Appendix E FarmWare Case Studies

This appendix contains four case studies designed to introduce the FarmWare software program and the technical and economic feasibility assessments that must be completed when investigating the potential for methane recovery. The following case studies are presented:

Appendix E-1 Case Studies

Dairy Plug Flow Digester

Farm Profile

Moo's Milkers is currently a 700 milker freestall dairy in Tillamook County, Oregon. There are three buildings at this facility: the parlor, freestall barn, and the feed apron. Manure is hose-washed from the parlor and is routed to an anaerobic lagoon. Freestall and feed apron manure is scraped through a separator after from which the liquid effluent is pumped into a storage pond and the solids are stored and sold to neighboring horticultural operations. The solids in the anaerobic lagoon are scraped off by a back hoe, stored and sold as well. The remaining liquid effluent is pumped to the secondary storage pond.

Mr. Moo wishes to expand his milk herd to 1,000 cows and realizes that in order to do this he needs a larger capacity manure handling system. He heard that AgSTAR could provide a solution that is cost effective, meets his farm's energy needs, and is environmentally sound. Mr. Moo would like to see how a methane recovery system could work for him and his dairy.

1. Preliminary Screening for Project Opportunities

A quick review of the farm by the operator, Mr. Moo, using the checklists provided in Chapter2 reveals that:

- There will be at least 1,000 cows at the confined facility;
- The manure is collected as a semi-solid from the freestall to the lagoon and a s slurry from the parlor to the secondary lagoon;
- There is a need for on-farm energy; and
- The farm employs a few people capable of managing biogas technology and parts for the system are relatively accessible.

The above conditions are promising for biogas technology. So, we move on to the next stage of the analysis.

2. Technical and Economic Feasibility Assessment

This assessment consists of four steps:

(1) determining which digester is appropriate for your facility;

(2) gathering facility data for the FarmWare assessment

(3) performing the FarmWare assessment; and

(4) evaluating the results.

Each step is discussed in turn.

2.1 Match Digester to Your Facility

The type of digester to use depends on the climate and total solids content of the manure.

- **Climate.** The farm is located in Tillamook County, Oregon, a region north of the line of climate limitation (see Exhibit 4-1 in Chapter 4). The appropriate energy recovery technology for this location would therefore be a complete mix or plug flow digester.
- **Total Solids Content.** The manure from the freestall barn and the feed apron is scraped three times a week, providing an influent relatively close to the "as excreted" total solids value of 12% (see Exhibit 4-4 in Chapter 4). *Note: The flush manure from the milking parlor will not be considered in this analysis. Flush manure in a lagoon will be stored at temperatures near the ambient temperature of the region, temperatures which during the cooler months of the year will not be optimal for biogas production.*

For a facility with such climatic and manure conditions, Exhibit 4-4 in Chapter 4 indicates that the manure management/energy recovery technology is a **plug flow digester.**

2.2 Complete Evaluation Forms

These forms record the data required for the FarmWare analysis. The completed evaluation form for Mr. Moo's facility is attached.

2.3 Enter Information Into FarmWare

Once the evaluation forms are complete, the information is entered into FarmWare. For information on how to use FarmWare, refer to the FarmWare manual, which can be found in Appendix D. Mr. Moo completed the FarmWare assessment for his facility as follows.

2.3.1 Site Climate Information

The first step is to enter the location of Moo's Milkers into FarmWare. Click on the climate icon on the tool bar or select **Location and Climate** from the **Design** menu.

➡ *From the drop down lists, select Tillamook County, Oregon.*

The completed Site Location and Climate Screen is shown in Figure 1:

Appendix E-1 Case Studies

Dairy Plug Flow Digester

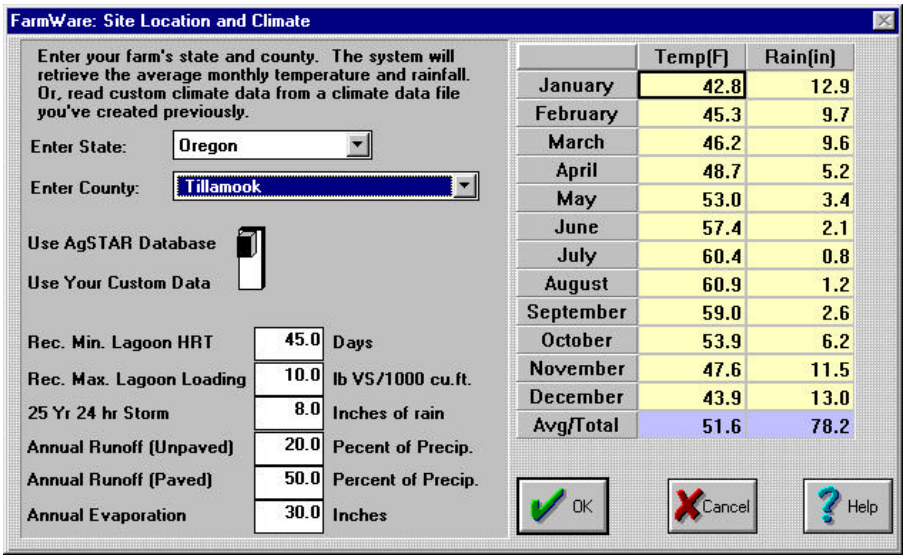


Figure 1: Site Location and Climate Screen

FarmWare has retrieved the average temperature and rainfall data for Tillamook County, OR as well as other climate data including the 25-year, 24-hour storm event. The temperature and rainfall data is based on National Climate Data Center (NCDC) data.

2.3.2 Farm Type

The next step is to enter information about the farm type and manure collection and treatment methods. Since Mr. Moo is planning on increasing his herd size he must plan the manure management/energy production system according to the anticipated size. Mr. Moo may continue his management of the parlor manure by flushing it into the anaerobic lagoon. The scraped manure from the freestall barn and feed apron however, will be treated in a plug flow digester as determined above in Section 2.1. Click on the farm type icon on the tool bar or select **Farm Type** from the **Design** menu.

- *Select **Dairy: Freestall** from the "Select a Type of Farm" drop down list.*
- *Enter **1,000** in the "Select a Farm Size" box.*
- *Select **Flush Parlor and Scrape the Rest** from the "Select a Manure Collection Method" drop down list.*
- *Select **Anaerobic Lagoon** from the "Select a Manure Treatment/Storage Facility" drop down list.*
- *Check the **Plug Flow Digester** box in the lower left hand corner of the screen.*

These selections are used to create a manure template for Moo's Milkers. The completed Farm Type screen for Moo's Milkers is shown in Figure 2:

Appendix E-1 Case Studies

Dairy Plug Flow Digester

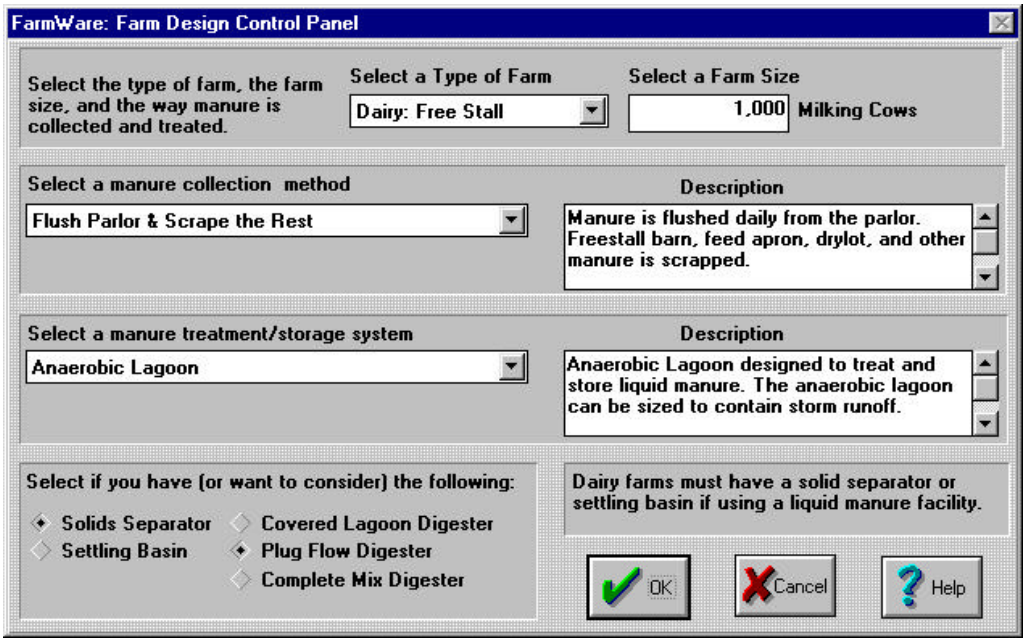


Figure 2: Farm Type Screen

Click on OK to save and exit this screen.

2.3.3 Livestock Populations

The next step is to enter the number of animals at Moo's Milkers. Click on the livestock number icon on the tool bar or select **Livestock Number** from the **Design** menu.

The Livestock Control Panel contains a table of default animal numbers and weights which are based on the type and size of farm entered in the Farm Type screen (in this case 1,000 cow freestall dairy). You may edit these numbers by clicking in the appropriate cream colored boxes and entering the correct values.

For Moo's Milkers, enter the following animal numbers:

- *Cow-Lac:* *1,000*
- *Cow-Dry:* *150*
- *Heifer:* *150*
- *Calf:* *0*
- *Bull:* *12*

Note: The manure from the calves at Moo's Milkers is contaminated with straw which would clog the digester influent and effluent pipes. This manure is disposed of separately. To ensure that the calf manure is not included in this analysis, be sure to enter "0" in the number of calves row in the Livestock Number screen.

The completed Livestock Number screen is shown in Figure 3.

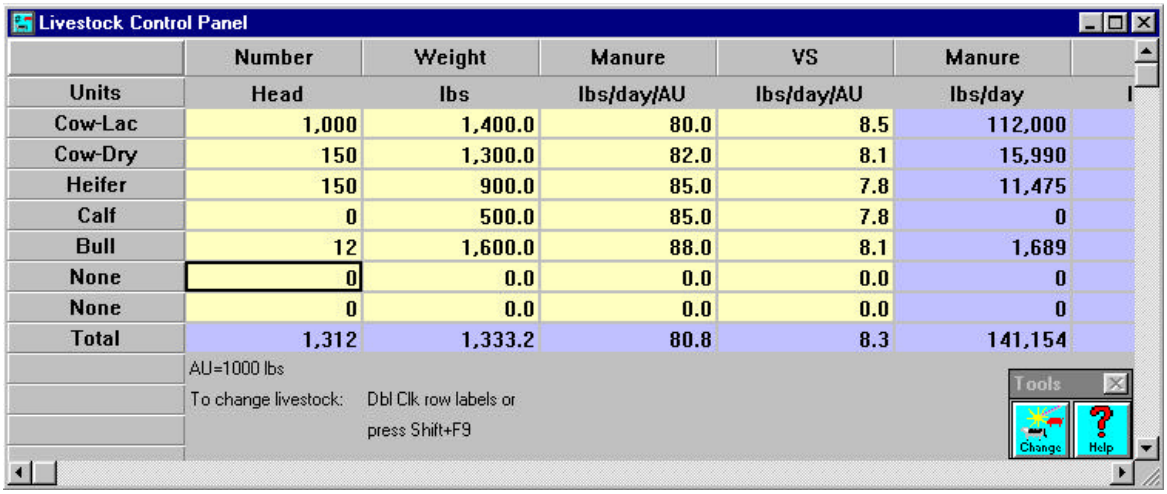


Figure 3: Livestock Number Screen

Double click on the upper left hand corner of this screen to exit.

2.3.4 Livestock Facilities

The next step is to define the number of hours the animals spend in the different farm facilities each day. Click on the facility icon on the tool bar or select **Livestock Facilities** from the **Design** menu.

The first step is to delete the facilities which are not present a Moo's Milkers. Moo's Milkers has only a Parlor, freestall barn, and a feed apron. The default facilities (in this case, the Drylot and the Barn) listed in this screen should therefore be deleted to avoid confusion.

➡ *Double click on the Drylot cell in the first column of the Livestock Facilities table. In the Change Facility Dialog Box select "None" from the drop down menu.*

➡ *Follow the above procedure for the Barn.*

The next step is to enter the hours that the animals spend in the existing facilities.

➡ *Enter the hours in the Livestock Facilities table as outlined in the table below:*

Facility/Animal Type	Cow-Lac	Cow-Dry	Heifer	Calf *	Bull
Parlor	4.5	0.0	0.0	0.0	0.0
Freestall Barn	8.5	10.5	10.5	0.0	9.0
Feed Apron	11.0	13.5	13.5	0.0	15.0

** Remember, as described in Section 2.3.3 we are not going to consider the calf manure in this analysis and we will thus zero out the time the calves spend in the facilities*

The completed Livestock Facility Control Panel should look like Figure 4 below:

Facility Control Panel

	Cow-Lac	Cow-Dry	Heifer	Calf	Bull	None
Parlor	4.5	0.0	0.0	0.0	0.0	0.0
Free Stall Barn	8.5	10.5	10.5	0.0	9.0	0.0
Feed Apron	11.0	13.5	13.5	0.0	15.0	0.0
None	0.0	0.0	0.0	0.0	0.0	0.0
None	0.0	0.0	0.0	0.0	0.0	0.0
Process Water	0.0	0.0	0.0	0.0	0.0	0.0
Watershed	0.0	0.0	0.0	0.0	0.0	0.0
Total	24.0	24.0	24.0	0.0	24.0	0.0
	Enter Hours per	day each animal	spends in each	facility.		

Figure 4: Livestock Facility Control Panel

Double click on the upper left hand corner of this screen to exit.

2.3.5 Manure Management

The next step is to define the individual components of the manure management system. Click on the train icon on the tool bar or select **Management Train** from the **Design** menu.

The **Management Train** screen (Figure 5) shows the collection and treatment methods for the facilities at the farm. In this example, this screen shows that the manure from the Parlor is flushed through a solid separator into an anaerobic lagoon. This screen also shows that the manure is scraped from the freestall barn and the feed apron into a mix tank and ultimately is stored/treated in a plug flow digester. Note that the "Mix Tank' for the Feed Apron is labeled with the same color as the "Mix Tank for the Freestall Barn but is displayed with a smaller text size. This is to show that the manure from the Feed Apron flows into the same mix tank as the manure from the Freestall Barn and therefore follows the same path through the storage/treatment process.

Manure Management Train Control Panel

	Collection	Component 1	Component 2	Component 3
Parlor	*Flush*	*Sld Separator*	*Anaerobic Lagoon*	*Fld Apply-Liq*
Free Stall Barn	*Scrape*	*Mix Tank*	*Plug Flow Digester*	*Fld Apply-Liq*
Feed Apron	*Scrape*	*Mix Tank*		
None				
None				
Process Water	*Use Process Water*	*Sld Separator*		
Watershed	*Collect Rainfall*	*Anaerobic Lagoon*		
Methane Shack	*Engine generator*			
	Italics = Default Design	Non-Italic = User Design		

Figure 5: Manure Management Train Screen

Each of the components in this screen should be accurately defined to ensure that the methane recovery system is sized appropriately. To define a component you may double click on the component name

(with the larger text size) or click on the define component in the floating toolbar. Each of the component definition screens are described below:

Flush

The manure from the parlor is flushed regularly into a solids separator and into an anaerobic lagoon. Though this manure does not enter the methane recovery facility (in this case, the plug flow digester) we should accurately describe the system for the purposes of estimating the costs and benefits.

Place the cell cursor over the Flush component immediately to the right of the Parlor Facility in this screen. Double click on this cell or click on the Design component icon in the floating tool box.

- *Enter **1** in the "Number of Flush Tanks or Valves" box*
- *Enter **3** in the "Flush Frequency" box.*
- *Enter **13,000** in the "Water per Flush" box.*

The finished screen is shown in Figure 6.

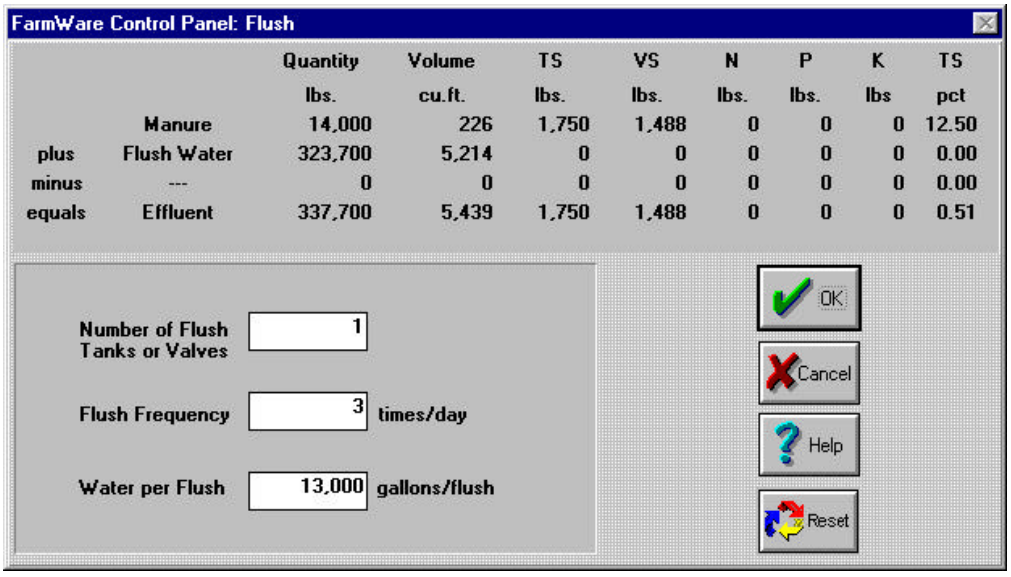


Figure 6: Parlor Flush Screen

Scrape

The manure from the Freestall Barn and the Feed Apron is scraped 3 times each week. With the methane recovery system, this manure will be pre-treated in a mix tank and then treated in a plug flow digester. Both the Freestall Barn and the Feed Apron scrape components must be defined to accurately determine the size of the mix tank and the plug flow digester.

Place the cell cursor over the Scrape component immediately to the right of the Freestall Barn Facility in this screen. Double click on this cell or click on the Design component icon in the floating tool box.

- *Enter **3** in the "Scrape Frequency" box*

➡ *Select **Week** from the "Times Per" drop down list.*

➡ *Select **Tractor Scraper** from the "Type of Scraper" drop down list.*

The finished Freestall Barn Scrape screen is shown in Figure 7.

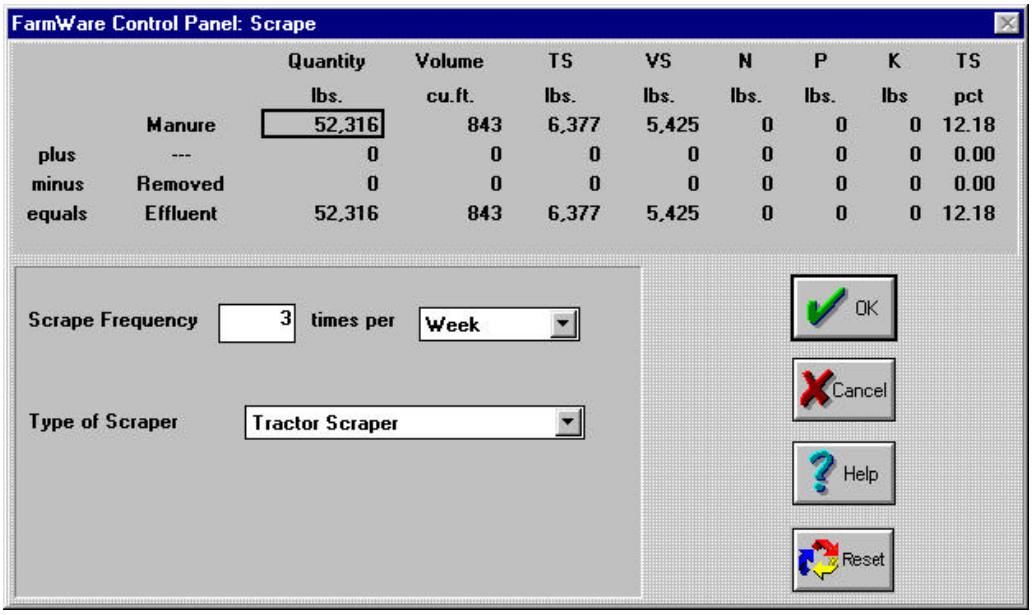


Figure 7: Freestall Barn Scrape screen

➡ *Enter the same information described above into the Feed Apron Scrape screen.*

Collect Rainfall

The rainfall falling on the area surrounding the facilities at Moo's Milkers must be stored in the anaerobic lagoon facility. To account for this, the area over which the runoff will be collected must be entered in the FarmWare system.

Place the cell cursor over the Collect Rainfall component immediately to the right of the Watershed Facility in this screen. Double click on this cell or click on the Design component icon in the floating tool box.

➡ *Enter **10.0** in the "Area over which the runoff will be collected" box.*

➡ *Enter **5.0** in the "Fraction of this area that is paved" box.*

The finished Runoff Collection screen is shown in Figure 8.

Appendix E-1 Case Studies

Dairy Plug Flow Digester

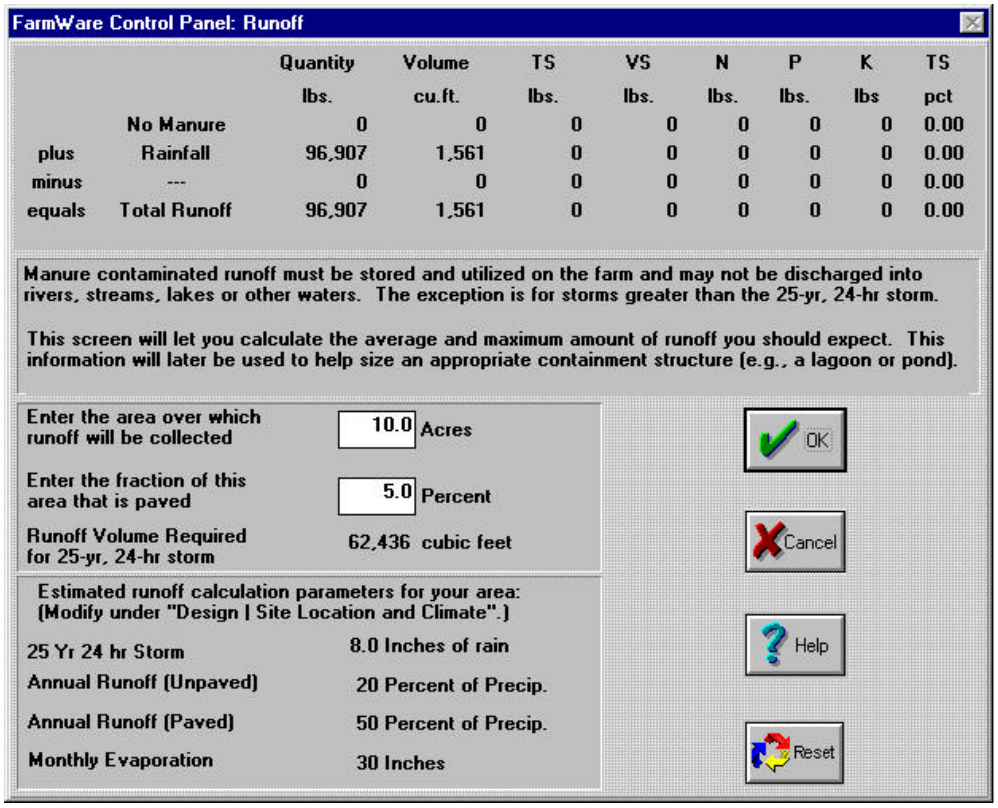


Figure 8: Runoff Collection screen

NOTE: The rainfall collected is stored in the Anaerobic Lagoon component of the manure management system. This will not affect the sizing of the methane recovery system (the plug flow digester).

Solid Separator

The manure from the parlor passes through a separator before entering the anaerobic lagoon. The type of separator and the separation efficiency must be defined to accurately size the anaerobic lagoon.

Place the cell cursor over the Solid Separator component in the Parlor Row of this screen. Double click on this cell or click on the Design component icon in the floating tool box.

➡ *Select **Screw Press** from the "Type of Separator" drop down list.*

➡ *Accept the defaults for the remaining features of the solid separation system.*

The finished Solid Separator screen is shown in Figure 9.

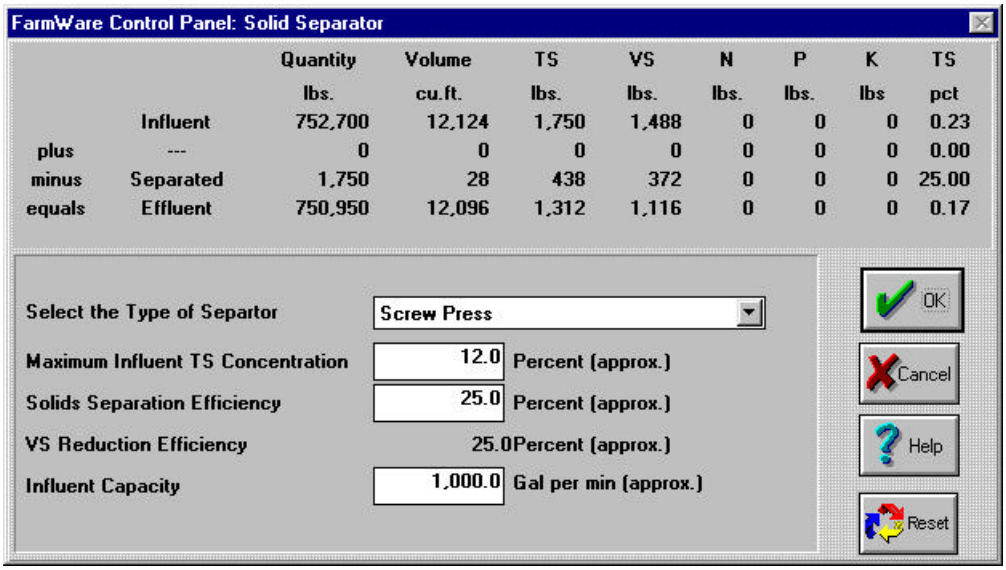


Figure 9: Solid Separator screen

Mix Tank

The manure from the freestall barn and feed apron passes through a mix tank before entering the plug flow digester methane recovery system. The characteristics of the mix tank must be defined to accurately size the tank and account for the costs associated with it.

Place the cell cursor over the Mix Tank component in the Freestall Barn row of this screen. Double click on this cell or click on the Design component icon in the floating tool box.

➡ *Enter **10.0** in the "Mix Tank Depth" box.*

The finished Mix Tank screen is shown in Figure 10.

Appendix E-1 Case Studies

Dairy Plug Flow Digester

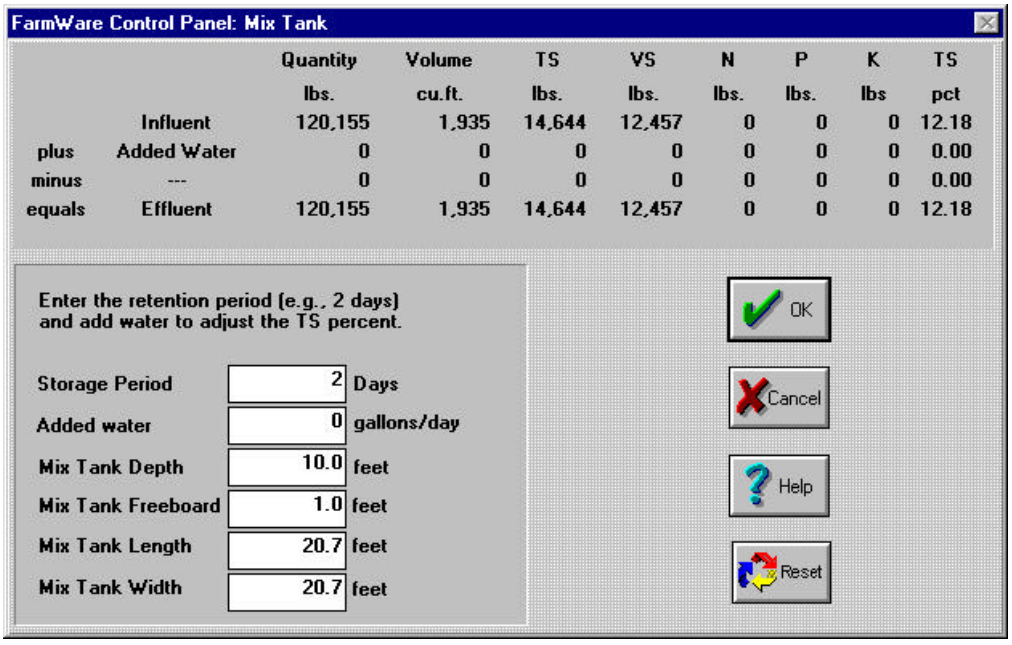


Figure 10: Mix Tank screen

Anaerobic Lagoon

The anaerobic lagoon stores the manure and water from the milking parlor, the process water from the milking parlor, and the rainfall collected over the runoff area. While some anaerobic lagoons may be covered to trap methane, this lagoon will not be covered since methane will not be produced at high levels year round due to the cool climatic conditions. This lagoon should be designed accurately however to assess any additional costs that may be associated with retrofitting the system to account for the plug flow digester.

Place the cell cursor over the Anaerobic Lagoon component in the Parlor row of this screen. Double click on this cell or click on the Design component icon in the floating tool box.

➡ *Double click on the cream colored cell corresponding to the sideslope in the lower left hand corner of the screen.*

➡ *Enter **1.0** in the Sideslope value dialog box.*

The finished Anaerobic Lagoon screen is shown in Figure 11.

Appendix E-1 Case Studies

Dairy Plug Flow Digester

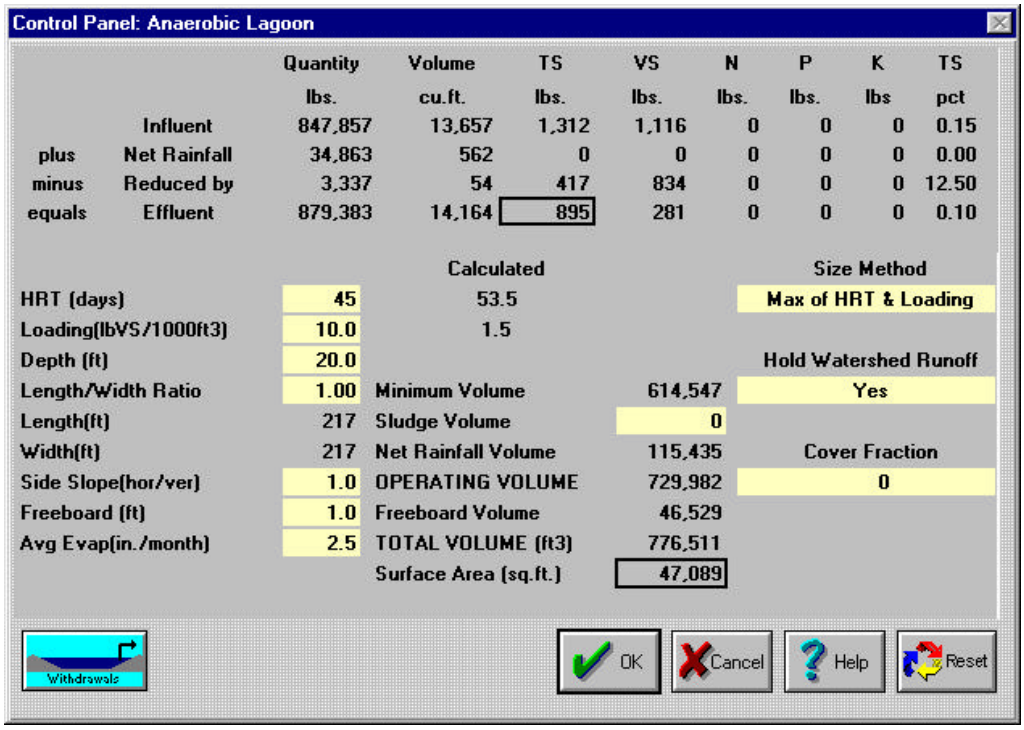


Figure 11: Anaerobic Lagoon Screen

Plug Flow Digester

The plug flow digester will be the primary component in the new methane recovery system at Moo's Milkers. It is imperative that this component be designed as accurately as possible.

Place the cell cursor over the Plug Flow Digester component in the Freestall Barn row of this screen. Double click on this cell or click on the Design component icon in the floating tool box.

The deeper the plug flow digester, the less surface area is needed to be covered to trap the gas. This ultimately will reduce the costs associated with the system as the cover is reduced. At Moo's Milkers, the soil conditions will allow for a digester depth of 16 feet.

➡ *Enter **16.0** in the "Depth" box.*

The finished Plug Flow Digester screen is shown in Figure 12.

Appendix E-1 Case Studies

Dairy Plug Flow Digester

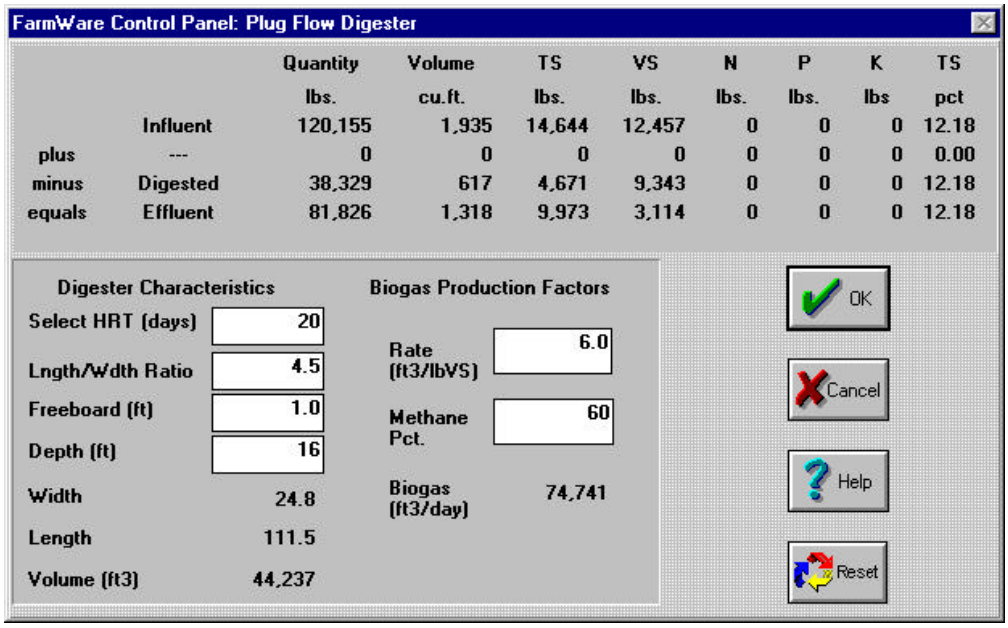


Figure 12: Plug Flow Digester screen

Engine Generator

The cool climatic conditions in Tillamook County, Oregon require that the digester be heated with supplemental heat generated from the biogas produced within the digester. A heat exchanger will provide enough heat to keep the manure at the optimal biogas production temperature. To ensure that the costs associated with a heat exchanger are included in the financial analysis of Moo's Milkers we must edit the Engine Generator Control Panel. Place the cell cursor over the Engine Generator component in the Methane Shack row in Manure Management Train screen. Double click on this cell or click on the Design component icon in the floating tool box.

➡ *Select "**Yes**" from the "Include Heat Recovery?" drop down list.*

➡ *Enter **100** in the "Enter the engine generator size you want" box.*

The finished Engine Generator screen is shown in Figure 13.

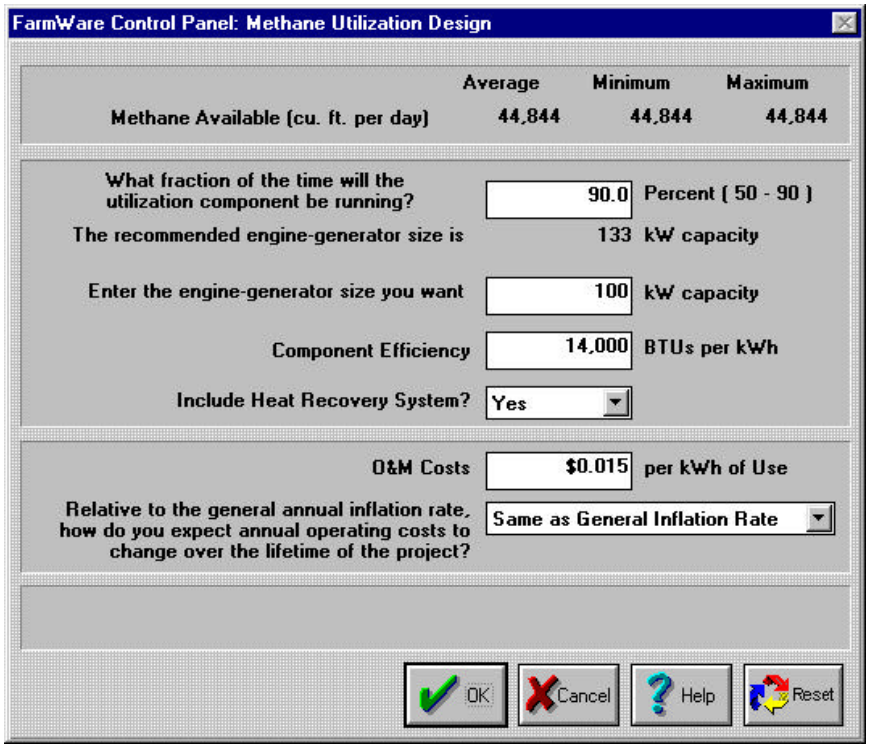


Figure 13: Engine Generator screen

2.3.6 Energy Information

The final step in this case study is to enter the energy use and rates at Moo's Milkers. Click on the energy icon on the tool bar or select **Energy Prices** from the **Design** menu.

In this screen, you may enter the amount of electricity and propane purchased per year as well as the price per kWh of electricity and the price per gallon of propane. Default values for each of the above categories are provided and should be edited to most accurately reflect the current energy costs to Moo's Milkers.

- *Enter **803,000** for the amount of electricity purchased per year.*
- *Enter **$0.08** for the price per kWh of electricity.*
- *Enter **$10,000** for the amount of propane purchased per year.*
- *Enter **$0.90** for the price per gallon of propane.*

The total annual cost of electricity should be $64,240 and the total annual cost of propane should be $9,000. The completed Energy Prices screen for Moo's Milkers is shown in Figure 14.

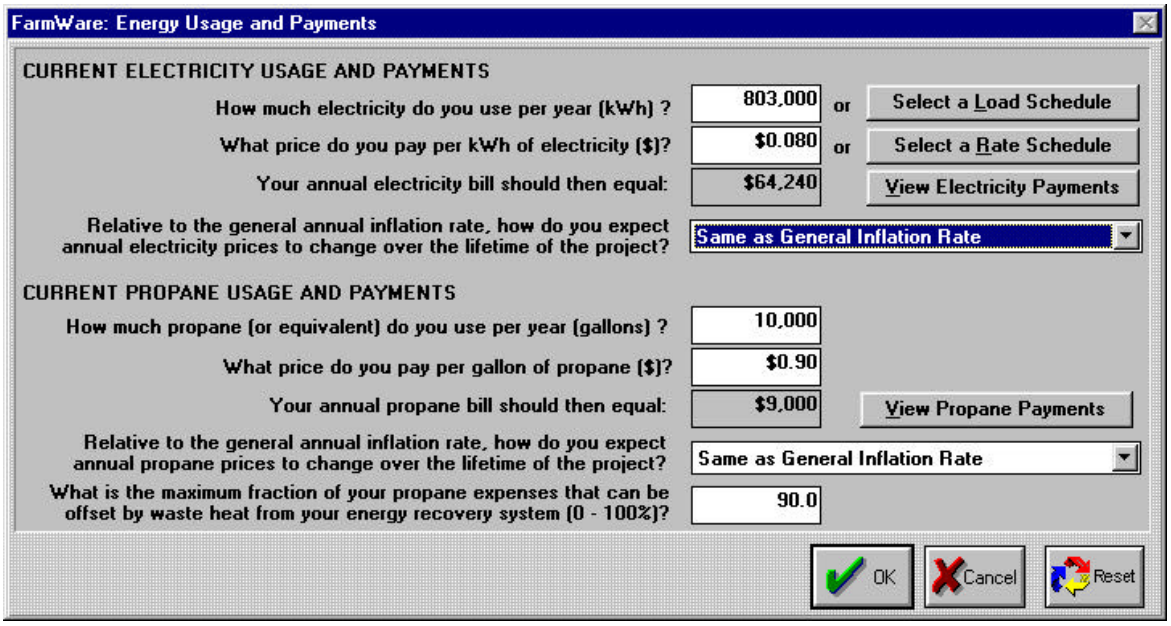


Figure 14: Energy Usage Screen

Click on OK to save and exit.

Note: More detailed energy usage and rate schedules may be entered using RateVision. Please see the RateVision manual for more details.

2.4 Evaluate Results

To determine whether a biogas recovery system at this farm will be a profitable investment. Click on the quick analysis icon the tool bar or select ***Quick Financial Report*** from the **Analysis** menu. The screen for this report is shown in Figure 15 below. The top part of this report contains estimates for the total capital costs, annual benefits, and annual operating costs of the selected system. The bottom of the box contains values for the NPV, simple payback, NPV payback, IRR, and a message regarding the potential profitability of the selected system.

Appendix E-1 Case Studies

Dairy Plug Flow Digester

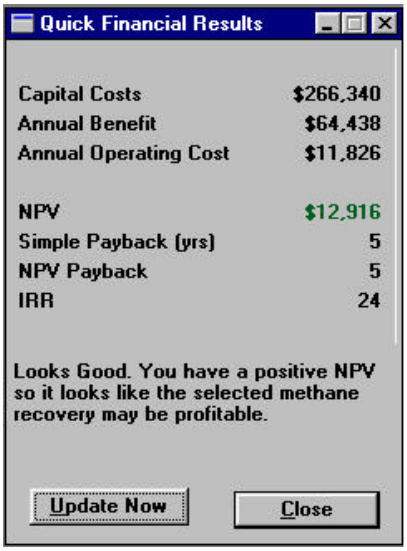


Figure 15: Quick Financial Results screen

The **Quick Report** shows us that the total capital cost of installing a covered lagoon digester at Moo's Milkers is $266,000. FarmWare estimates that average annual offset benefits are $64,000 and average annual operating costs are about $12,000. These costs and benefits yield an NPV of approximately $13,000. In addition, this project is estimated to have a payback of 5 years and an internal rate of return of 24%.

As indicated in the message at the bottom of this report, these measures of economic feasibility show that the installation of a methane recovery system at Moo's Milkers should be a profitable investment. Mr. Moo should invest in this project for his farm.

AgSTAR

Evaluation Form: Dairy Facility

Farm Name: *Moo's Milkers*
Contact Name: *Mr. Moo*
Phone Number: _____ **Date:** _____

1. SITE CLIMATE INFORMATION

State: *Oregon* County: *Tillamook*

2. FARM TYPE

Type of Farm		Size of Farm		Manure Collection Method		Manure Management	
X	Freestall	*1,000*	milker		Flush Everything		Covered Lagoon
	Drylot		milker		Flush Parlor and Freestall Barn		Complete Mix
	Tiestall		milker		Flush Parlor and Feed Apron	*X*	Plug Flow
	Other (specify)			*X*	Flush Parlor Only		

3. LIVESTOCK POPULATIONS

1,000	Cows-lac	*150*	Cows-dry	*159*	Heifers	*0*	Calves	*12*	Bulls		other

4. ANIMAL DISTRIBUTION

Indicate the number of hours the animals spend in each area, per day:

	Milking Parlor	Barn	Freestall Barn	Feed Apron	Drylot	Pasture	Other
Cows-lactating	*4.5*		*8.5*	*11.0*			
Cows-dry			*10.5*	*13.5*			
Hiefer			*10.5*	*13.5*			
Calf							
Bull			*9*	*15*			

4. MANURE MANAGEMENT

Recycle Flush Systems

Building	# of Tanks	Gallons Per Tank	Flush Frequency (# times/day)	Total Water (gallons/day)
	A	B	C	A x B x C
Parlor	*1*	*3*	*13,000*	*39,000*
Free Stall Barn				
Feed Apron				

Scrape Systems

_____ daily *3X* weekly _____ monthly _____ other

Solids Separators

_____ settling basin _____ vibrating screen _____ inclined screen
X screw press _____ hydrocyclone _____ other (specify)

5. ENERGY INFORMATION

(Complete this section, or bypass it by attaching copies of past 12 months of energy bills)

Overall Energy Costs

Annual Electricity Costs: *64,240* $/year Annual Propane Cost: *10,000* $/year
Average Electricity Cost: *0.08* $/kWh Average Propane Cost: *0.90* $/gallon

Monthly Energy Bills (last 12 months)

	Peak	Electric		Propane	
	kW	(kWh)	(Cost)	(gals)	(Cost)
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					

Appendix E-2 Case Studies

Freestall Dairy: Covered Lagoon

Farm Profile

Snow Falls Dairy is currently a 500 milker freestall dairy in Tulare County, California. The owner of the dairy, Mr. Frosty, is concerned about the air and water quality issues in his area and is looking for better management practices which consider these issues. He is also interested in alternative energy sources and wants to try to offset his current electricity prices using manure generated methane. Mr. Frosty contacted AgSTAR and wishes to take the first step toward more environmentally conscious manure management.

3. Preliminary Screening for Project Opportunities

A quick review of the farm by the operator, Mr. Frosty, using the checklists provided in Chapter 2 reveals that:

- There will be at least 500 cows at the confined facility;
- The manure is flushed from the milking parlor, feed apron, and freestall barns and thus is managed as a liquid;
- There is a need for on-farm energy; and
- The owner is a committed to seeing methane recovery work at his facility.

The above conditions are promising for biogas technology. So, we move on to the next stage of the analysis.

4. Technical and Economic Feasibility Assessment

This assessment consists of four steps:

(1) determining which digester is appropriate for your facility;

(2) gathering facility data for the FarmWare assessment

(3) performing the FarmWare assessment; and

(4) evaluating the results.

Each step is discussed in turn.

4.1 Match Digester to Your Facility

The type of digester to use depends on the climate and total solids content of the manure.

- **Climate.** The farm is located in Tulare County, California, a region south of the line of climate limitation (see Exhibit 4-1 in Chapter 4). The climatic conditions at this location should be favorable for optimum biogas production year round from a covered lagoon system.

- **Total Solids Content.** The manure from the parlor and the feed apron is flushed with approximately 10 gallons of water for each gallon of manure. The resulting manure stream is therefore less than 2% (see Exhibit 4-4 in Chapter 4), the optimum solids content for covered lagoon systems.

For a facility with such climatic and manure conditions, Exhibit 4-4 in Chapter 4 indicates that the manure management/energy recovery technology is a **covered lagoon digester.**

4.2 Complete Evaluation Forms

These forms record the data required for the FarmWare analysis. The completed evaluation form for Mr. Frosty's facility is attached.

4.3 Enter Information Into FarmWare

Once the evaluation forms are complete, the information is entered into FarmWare. For information on how to use FarmWare, refer to the FarmWare manual, which can be found in Appendix D. Mr. Frosty completed the FarmWare assessment for his facility as follows.

4.3.1 Site Climate Information

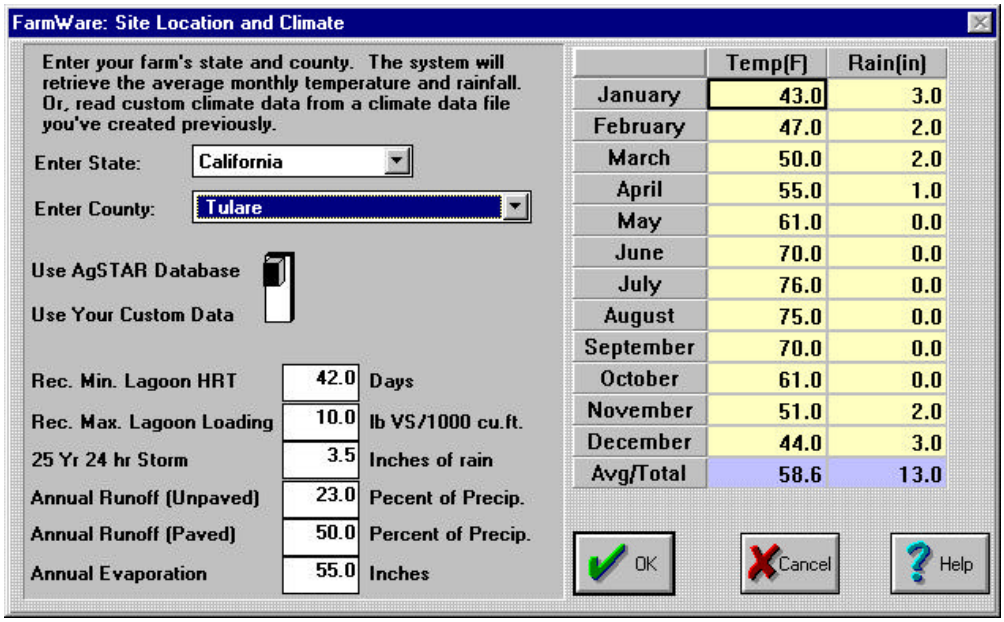
The first step is to enter the location of Snow Falls Dairy into FarmWare. Click on the climate icon on the tool bar or select **Location and Climate** from the **Design** menu.

➡ *From the drop down lists, select Tulare County, California.*

The completed Site Location and Climate Screen is shown in Figure 16:

Appendix E-2 Case Studies

Freestall Dairy: Covered Lagoon



	Temp(F)	Rain(in)
January	43.0	3.0
February	47.0	2.0
March	50.0	2.0
April	55.0	1.0
May	61.0	0.0
June	70.0	0.0
July	76.0	0.0
August	75.0	0.0
September	70.0	0.0
October	61.0	0.0
November	51.0	2.0
December	44.0	3.0
Avg/Total	58.6	13.0

Figure 16: Site Location and Climate Screen

FarmWare has retrieved the average temperature and rainfall data for Tulare County, CA as well as other climate data including the 25-year, 24-hour storm event. The temperature and rainfall data is based on National Climate Data Center (NCDC) data.

4.3.2 Farm Type

The next step is to enter information about the farm type and manure collection and treatment methods. It is recommended that Mr. Frosty excavate a new primary lagoon for methane recovery and modify the current lagoon for secondary storage. Click on the farm type icon on the tool bar or select **Farm Type** from the **Design** menu.

- *Select **Dairy: Freestall** from the "Select a Type of Farm" drop down list.*
- *Enter **500** in the "Select a Farm Size" box.*
- *Select **Flush Everything** from the "Select a Manure Collection Method" drop down list.*
- *Select **Methane Recovery Lagoon** from the "Select a Manure Treatment/Storage Facility" drop down list.*
- *Check the **Covered Lagoon Digester** and **Solids Separator** boxes in the lower left hand corner of the screen.*

These selections are used to create a manure template for the Snow Falls Dairy. The completed Farm Type screen for Snow Falls Dairy is shown in Figure 17:

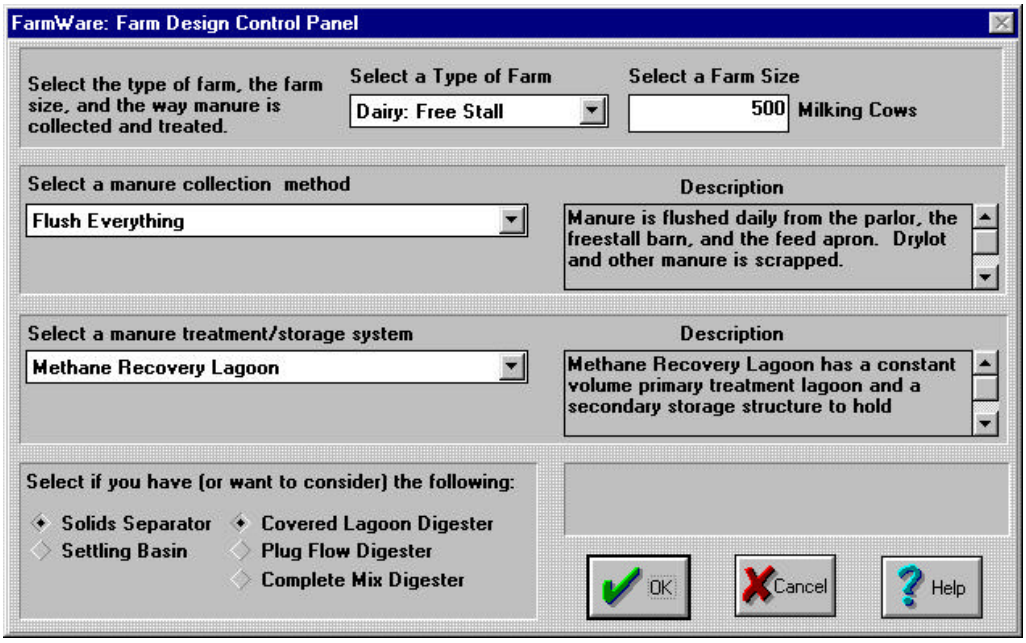


Figure 17: Farm Type Screen

Click on OK to save and exit this screen.

4.3.3 Livestock Populations

The next step is to enter the number of animals at Snow Falls Dairy. Click on the livestock number icon on the tool bar or select **Livestock Number** from the **Design** menu.

The Livestock Control Panel contains a table of default animal numbers and weights which are based on the type and size of farm entered in the Farm Type screen (in this case 500 cow freestall dairy). You may edit these numbers by clicking in the appropriate cream colored boxes and entering the correct values.

For Snow Falls Dairy, enter the following animal numbers:

- *Cow-Lac:* *500*
- *Cow-Dry:* *100*
- *Heifer:* *100*
- *Calf:* *150*
- *Bull:* *10*

The completed Livestock Number screen is shown in Figure 18.

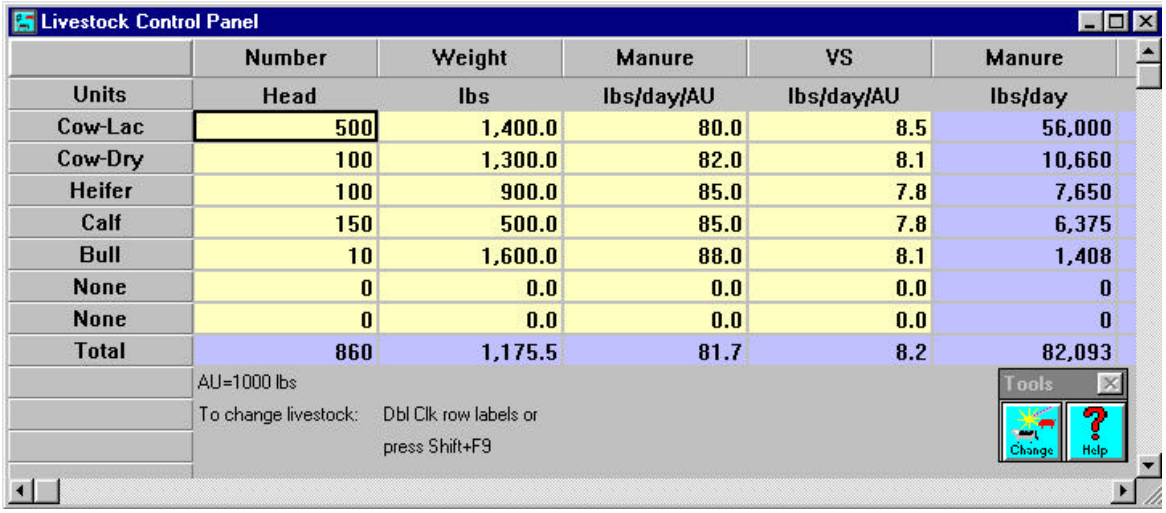


Figure 18: Livestock Number Screen

Double click on the upper left hand corner of this screen to exit.

4.3.4 Livestock Facilities

The next step is to define the number of hours the animals spend in the different farm facilities each day. Click on the facility icon on the tool bar or select **Livestock Facilities** from the **Design** menu.

➡ *Enter the hours in the Livestock Facilities table as outlined in the table below:*

Facility/Animal Type	Cow-Lac	Cow-Dry	Heifer	Calf *	Bull
Parlor	3	0	0	0	0
Freestall Barn	7	7	7	7	0
Feed Apron	10	10	10	10	10
Drylot	4	7	7	7	14
Barn	0	0	0	0	0
** Remember, as described in Section 4.3.3 we are not going to consider the calf manure in this analysis and we will thus zero out the time the calves spend in the facilities*					

The completed Livestock Facility Control Panel should look like Figure 19 below:

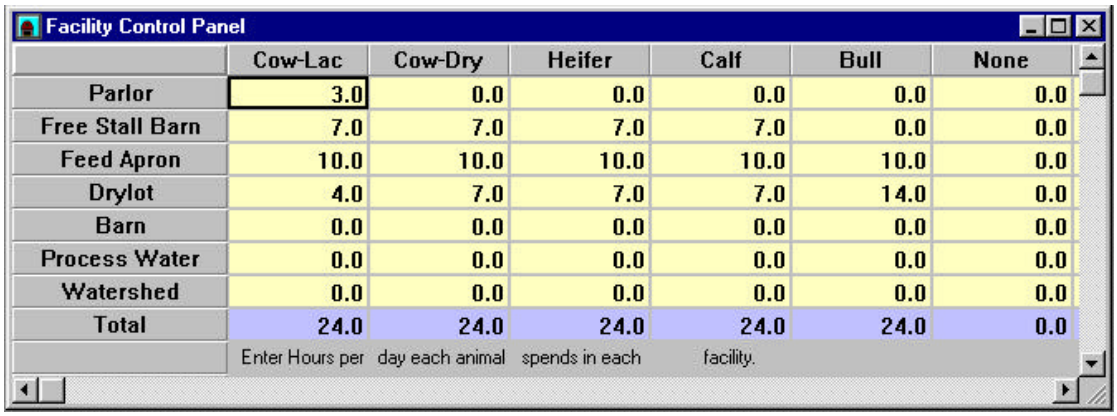


Figure 19: Livestock Facility Control Panel

Double click on the upper left hand corner of this screen to exit.

4.3.5 Manure Management

The next step is to define the individual components of the manure management system. Click on the train icon on the tool bar or select **Management Train** from the **Design** menu.

The **Management Train** screen (Figure 20) shows the collection and treatment methods for the facilities at the farm. In this example, this screen shows that the manure from the Parlor and Feed Apron is flushed through a solid separator into a primary lagoon. After being treated in the primary lagoon, this manure is stored in a secondary storage structure and later applied on the fields. The other manure is scraped at this farm and is stored in drystacks.

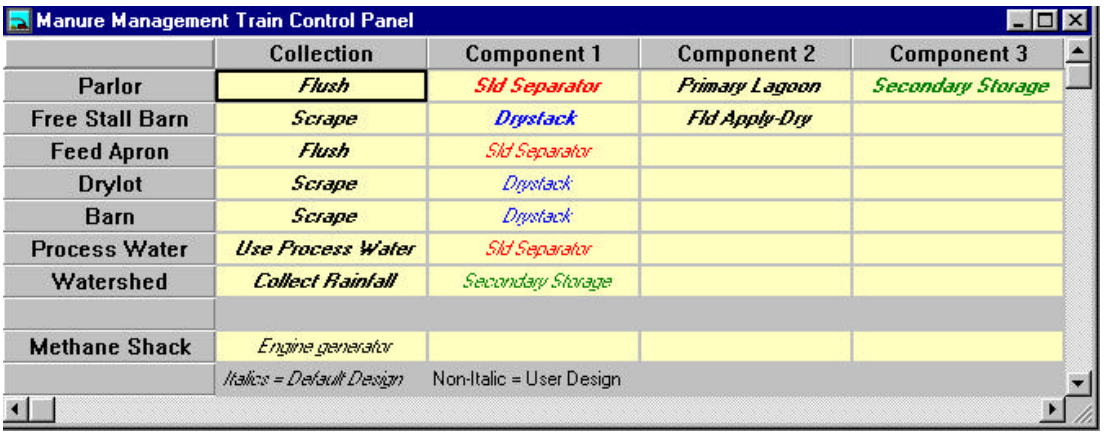


Figure 20: Manure Management Train Screen

You may wish to examine the characteristics of each of the components of the manure management train by double clicking on the cell you wish to analyze. For the purposes of this case study however, we will accept the default values for each component.

4.3.6 Energy Information

The final step in this case study is to enter the energy use and rates at Snow Falls Dairy. Click on the energy icon on the tool bar or select **Energy Prices** from the **Design** menu.

In this screen, you may enter the amount of electricity and propane purchased per year as well as the price per gallon of propane and the price per kWh of electricity. Default values for each of the above categories are provided and should be edited to most accurately reflect the current energy costs to Snow Falls Dairy.

In this example we will import RateVision rate schedules and load profiles. RateVision is an independent software program designed to allow you enter detailed rate and energy usage schedules. RateVision may be accessed by clicking on the Rates button on the toolbar or by selecting **Access RateVision** from the **RateVision** menu.

The RateVision manual is a part of this AgSTAR Handbook and may be found in Appendix D. A case study is presented in Chapter 3 of Appendix D for entering information into RateVision. Follow the instructions for this case study to enter the rates and load profile for Snow Falls Dairy. When you are finished, return to this section for details on how to import the files.

Upon completion of the RateVision case study in Chapter 3 of Appendix D, you are ready to import the RateVision rate and load schedules.

- *Click on the "Select a Load Schedule" button. Select "snowfall.lsc".*
- *Click on the "Select a Rate Schedule" button. Click on the "Add a Rate File" button in the top portion of the* ***Select An Electricity Rate File*** *dialog box. Select "snowfall.rat".*

Upon selection of the two files, FarmWare calculates the average energy price and the total electricity purchased per year. In this case, FarmWare finds that Snow Falls Dairy purchases 1,157,985 kWh per year at an average charge of $0.066/kWh for a total annual electricity bill of $75,952. The completed Energy Usage and Payments screen for Snow Falls Dairy is shown in Figure 21.

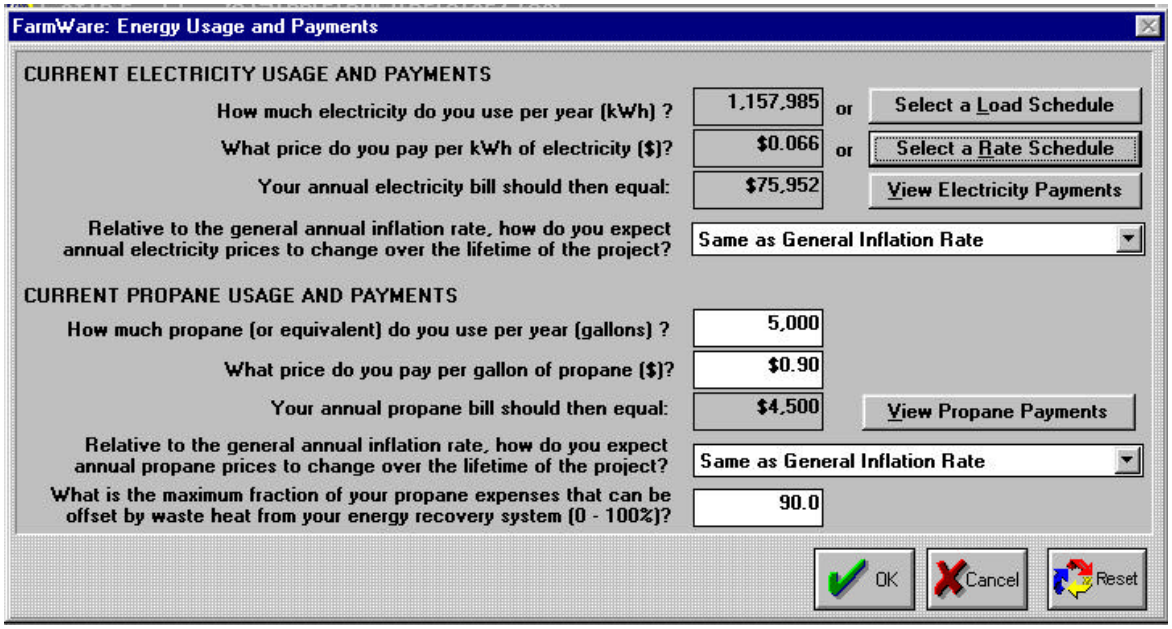


Figure 21: Energy Usage Screen

Click on OK to save and exit.

4.4 Evaluate Results

To determine whether a biogas recovery system at this farm will be a profitable investment. Click on the quick analysis icon the tool bar or select ***Quick Financial Report*** from the **Analysis** menu. The screen for this report is shown in Figure 22 below. The top part of this report contains estimates for the total capital costs, annual benefits, and annual operating costs of the selected system. The bottom of the box contains values for the NPV, simple payback, NPV payback, IRR, and a message regarding the potential profitability of the selected system.

Appendix E-2 Case Studies

Freestall Dairy: Covered Lagoon

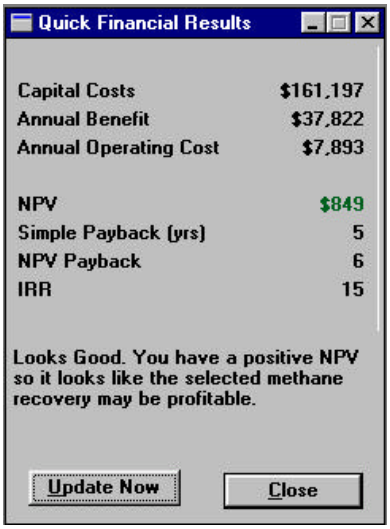


Figure 22: Quick Financial Results screen

The **Quick Report** shows us that the total capital cost of installing a covered lagoon digester Snow Falls Dairy is $161,000. FarmWare estimates that average annual offset benefits are $37,000 and average annual operating costs are about $8,000. These costs and benefits yield an NPV of approximately $850. In addition, this project is estimated to have a payback of 5 years and an internal rate of return of 15%.

As indicated in the message at the bottom of this report, these measures of economic feasibility show that the installation of a methane recovery system at Snow Falls Dairy should be a profitable investment. Mr. Frosty should invest in this project for his farm.

AgSTAR

Evaluation Form: Dairy Facility

Farm Name: *Snow Falls Dairy*
Contact Name: *Mr. Frosty*
Phone Number: _____ **Date:** _____

1. SITE CLIMATE INFORMATION

State: *California* County: *Tulare*

2. FARM TYPE

Type of Farm	Size of Farm	Manure Collection Method	Manure Management
X Freestall	*500* milker	*X* Flush Everything	*X* Covered Lagoon
Drylot	milker	Flush Parlor and Freestall Barn	Complete Mix
Tiestall	milker	Flush Parlor and Feed Apron	Plug Flow
Other (specify)		Flush Parlor Only	

3. LIVESTOCK POPULATIONS

500 Cows-lac *100* Cows-dry *100* Heifers *150* Calves *10* Bulls _____ other

4. ANIMAL DISTRIBUTION

Indicate the number of hours the animals spend in each area, per day:

	Milking Parlor	Barn	Freestall Barn	Feed Apron	Drylot	Pasture	Other
Cows-lactating	*3*		*7*	*10*	*4*		
Cows-dry			*7*	*10*	*7*		
Hiefer			*7*	*10*	*7*		
Calf			*7*	*10*	*7*		
Bull				*10*	*14*		

4. MANURE MANAGEMENT

Recycle Flush Systems

Building	# of Tanks	Gallons Per Tank	Flush Frequency (# times/day)	Total Water (gallons/day)
	A	B	C	A x B x C
Parlor	*1*	*4,800*	*2*	*8,400*
Free Stall Barn	*1*	*15,700*	*2*	*31,400*
Feed Apron	*1*	*22,700*	*2*	*45,400*

Scrape Systems

_____ daily _____ weekly _____ monthly _____ other

Solids Separators

_____ settling basin *X* vibrating screen _____ inclined screen
_____ screw press _____ hydrocyclone _____ other (specify)

5. ENERGY INFORMATION

(Complete this section, or bypass it by attaching copies of past 12 months of energy bills)

Overall Energy Costs

Annual Electricity Costs: *75,952* $/year Annual Propane Cost: *5,000* $/year
Average Electricity Cost: *0.066* $/kWh Average Propane Cost: _____ $/gallon

Monthly Energy Bills (last 12 months)

	Peak	Electric		Propane	
	kW	(kWh)	(Cost)	(gals)	(Cost)
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					

Appendix E-3 Case Studies

Swine Farrow-to-Finish Farm

Farm Profile

Polka Dot Pig Farm is a 7 year old 1,400 sow (over 12,000 total head) farrow to finish pig farm in Duplin county, North Carolina. There are 10 buildings at this facility all with slatted floors and an underfloor recycle flush system. Manure is currently flushed into a single cell lagoon. This lagoon has been a source of friction with the neighbors because of a seasonal odor problem. Mr. Dot heard about **AgSTAR** and thought that making his own **energy** and working on the **odors** at the same time made a lot of sense. Mr. Dot would like to know if a methane recovery facility makes sense for his farm.

5. Preliminary Screening for Project Opportunities

A quick review of the farm by the operator, Mr. Dot, using the checklists provided in Chapter 2 reveals that:

- There are over 12,000 hogs (on average) at his confined facility.
- The manure is collected as a slurry, at a single point (single cell lagoon); it is collected daily and is free of clumps of bedding.
- There is a need for on-farm energy. Annual electricity costs amount to over $80,000. Furthermore, odor is a problem.
- There is adequate technical support.

The above conditions are promising for biogas technology. So, we move on to the next stage of the analysis.

6. Technical and Economic Feasibility Assessment

This assessment consists of four steps:

(1) determining which digester is appropriate for your facility;

(2) gathering facility data for the FarmWare assessment

(3) performing the FarmWare assessment; and

(4) evaluating the results.

6.1 Match Digester to Your Facility

The type of digester to use depends on the climate and total solids content of the manure.

- **Climate.** The farm is located in Duplin County in North Carolina. This region is below the line of climate limitation (see Exhibit 4-1 in Chapter 4). So, it is warm enough for a covered lagoon considering energy recovery.
- **Total Solids Content.** The manure at the facility is flushed. Mr. Dot estimates the water to manure ratio to be 5:1. For such manure, Exhibit 4-4 in Chapter 4, indicates that the total solids content of the manure should be less than 2%.

For a facility with such climatic and manure conditions, Exhibit 4-4 in Chapter 4 indicates that the appropriate digester is a **covered lagoon.**

6.2 Complete Evaluation Forms

These forms record the data required for the FarmWare analysis. The completed evaluation form for Mr. Dot's facility is attached.

6.3 Enter Information Into FarmWare

Once the evaluation forms are complete, the information is entered into FarmWare. For information on how to use FarmWare, refer to the FarmWare manual, which can be found in Appendix D. Mr. Dot completed the FarmWare assessment for his facility as follows.

6.3.1 Site Climate Information

The first step is to enter the location of Polka Dot Pig farm into FarmWare. Click on the climate icon on the tool bar or select **Location and Climate** from the **Design** menu.

➡ *From the drop down lists, select Duplin County, North Carolina.*

The completed Site Location and Climate Screen is shown in Figure 1:

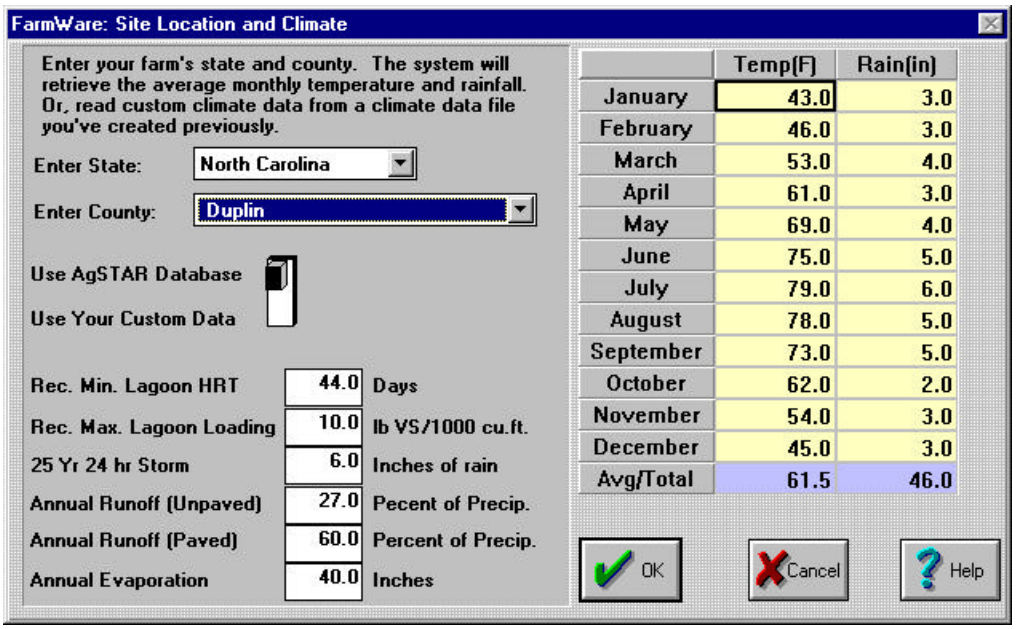


Figure 23: Site Location and Climate Screen

FarmWare has retrieved the average temperature and rainfall data for Duplin County, NC as well as other climate data including the 25-year, 24-hour storm event. The temperature and rainfall data is based on National Climate Data Center (NCDC) data.

6.3.2 Farm Type

The next step is to enter information about the farm type and manure collection and treatment methods. It is recommended that Mr. Dot build a new primary lagoon for methane recovery and modify the current lagoon for secondary storage. Click on the farm type icon on the tool bar or select **Farm Type** from the **Design** menu.

- *Select **Swine: Farrow to Finish** from the "Select a Type of Farm" drop down list.*
- *Enter **1,400** in the "Select a Farm Size" box.*
- *Select **Flush Everything** from the "Select a Manure Collection Method" drop down list.*
- *Select **Methane Recovery Lagoon** from the "Select a Manure Treatment/Storage Facility" drop down list.*
- *Check the **Covered Lagoon Digester** box in the lower left hand corner of the screen.*

These selections are used to create a manure template for the Polka Dot Pig Farm. The completed Farm Type screen for Polka Dot Pig Farm is shown in Figure 2:

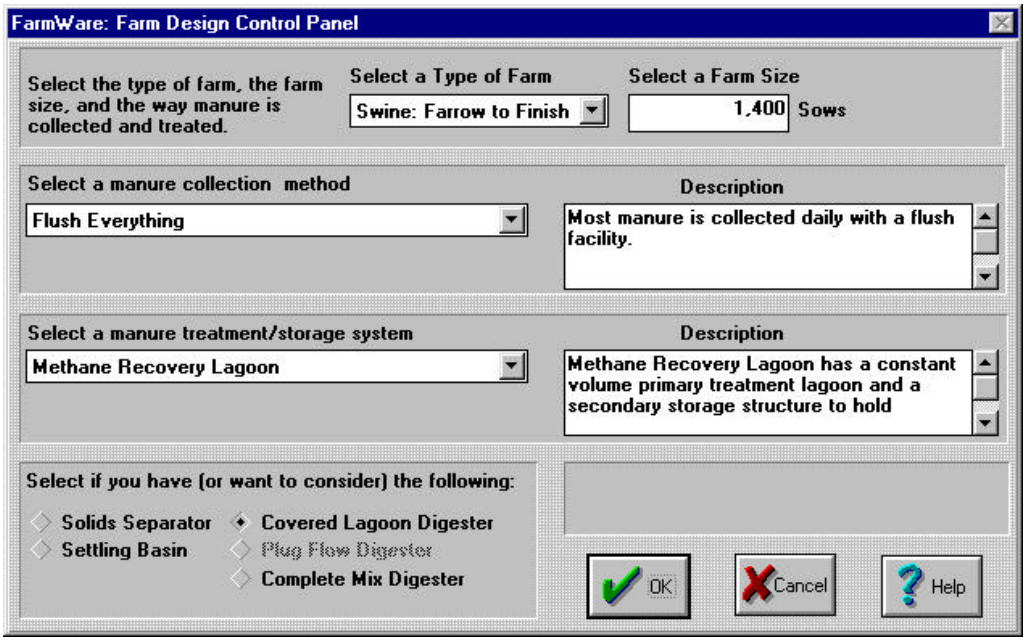


Figure 24: Farm Type Screen

Click on OK to save and exit this screen.

6.3.3 Livestock Populations

The next step is to enter the number of animals at Polka Dot Pig Farm. Click on the livestock number icon on the tool bar or select **Livestock Number** from the **Design** menu.

The Livestock Control Panel contains a table of default animal numbers and weights which are based on the type and size of farm entered in the Farm Type screen (in this case 1,400 sow farrow-to-finish). You

may edit these numbers by clicking in the appropriate cream colored boxes and entering the correct values.

For Polka Dot Pig Farm, enter the following animal numbers:

- *Sows:* *1,400*
- *Nursery:* *2,700*
- *Grower:* *4,300*
- *Finisher:* *4,850*
- *Boar:* *77*

The completed Livestock Number screen is shown in Figure 3.

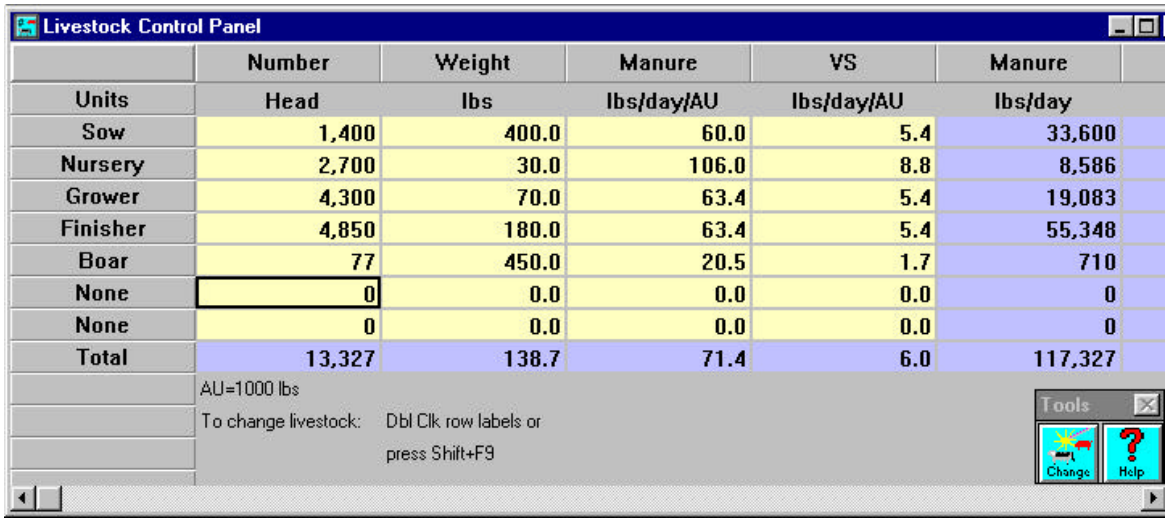


Figure 25: Livestock Number Screen

Double click on the upper left hand corner of this screen to exit.

6.3.4 Manure Management

The next step is to define the individual components of the manure management system. Click on the train icon on the tool bar or select **Management Train** from the **Design** menu.

The **Management Train** screen (Figure 5) shows the collection and treatment methods for the facilities at the farm. In this example, this screen shows that the manure from each of the confinement facilities is flushed and the manure from the drylot is scraped. All of the flushed manure goes into a methane recovery lagoon (primary lagoon and secondary storage) and is ultimately applied on the fields as a liquid.

Appendix E-3 Case Studies

Swine Farrow-to-Finish Farm

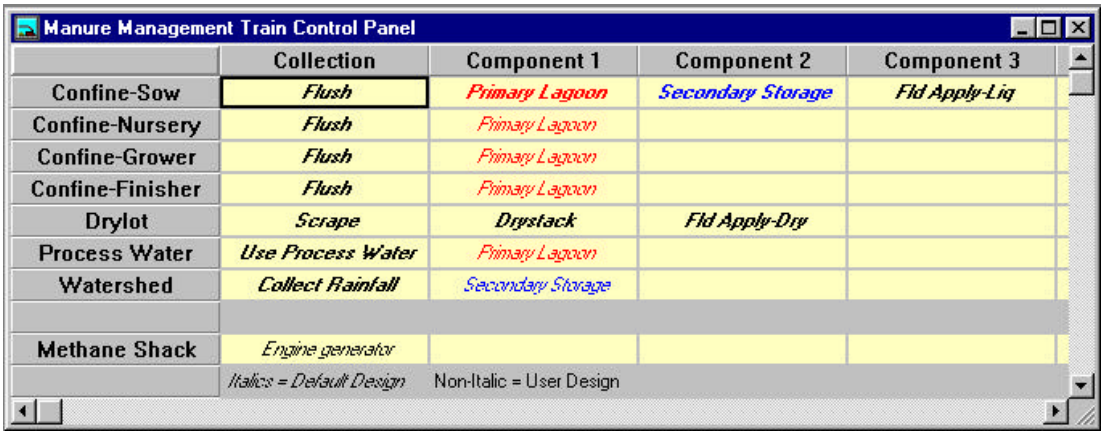


Figure 26: Manure Management Train Screen

To ensure that the primary lagoon is sized correctly you must accurately describe the water use in the flush manure collection systems. Each of the "Flush" components in this screen must therefore be defined.

Place the cell cursor over the Flush component immediately to the right of the Confine-Sow Facility in this screen. Double click on this cell or click on the Design component icon in the floating tool box.

➡ *Enter **10** in the "Number of Flush Tanks or Valves" box*

➡ *Enter **5** in the "Flush Frequency" box.*

➡ *Enter **948** in the "Water per Flush" box.*

The finished screen is shown in Figure 27.

This information is very important in designing a methane recovery facility as it directly affects the size of the primary lagoon. The more water that is being flushed, the greater the volume of the lagoon needed to store and treat the manure influent.

➡ *Follow the above steps to design the flush components for the nursery, grower, and finisher confinements using the information below:*

Table 1: Confinement Data for Polka Dot Pig Farm

Confinement	# of Tanks	Gallons/Tank	Flush Frequency
Nursery	6	450	4 x day
Grower	4	850	6 x day
Finisher	8	850	6 x day

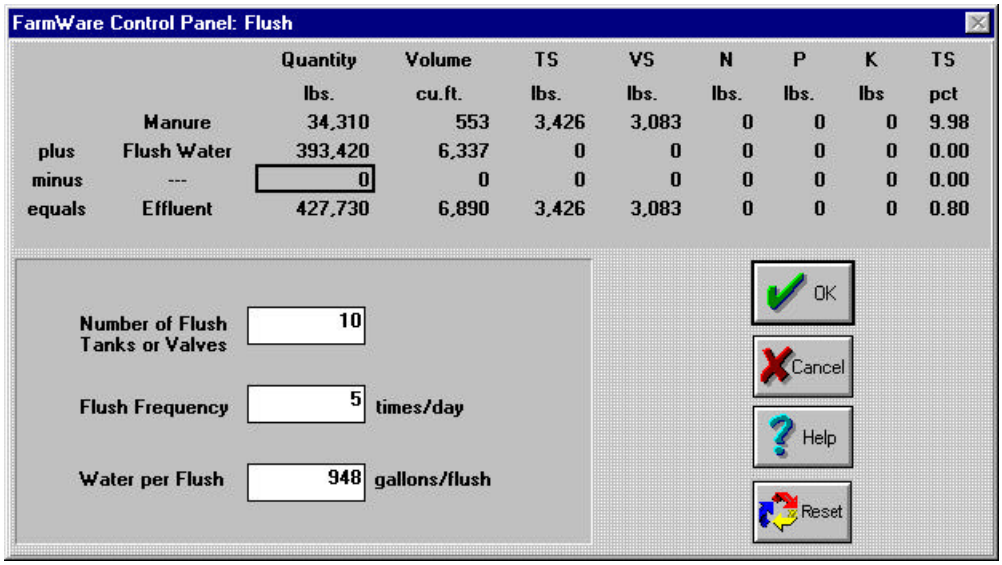


Figure 27: Flush Screen for the Polka Dot Pig Sow Confinement Building

When you are finished designing the flush components, double click in the upper left hand corner of the **Management Train** screen to save and exit.

6.3.5 Energy Information

The final step in this case study is to enter the energy use and rates at Polka Dot Pig Farm. Click on the energy icon on the tool bar or select **Energy Prices** from the **Design** menu.

In this screen, you may enter the amount of electricity and propane purchased as well as the current price per kWh of electricity and the current the price per gallon of propane. Default values for each of the above categories are provided and should be edited to most accurately reflect the current energy costs to Polka Dot Pig Farm.

- *Enter **1,200,000** for the amount of electricity purchased per year.*
- *Enter **$0.07** for the price per kWh of electricity.*
- *Enter **10,000** for the amount of propane purchased per year.*
- *Enter **$0.90** for the price per gallon of propane.*

The completed Energy Prices screen for Polka Dot Pig Farm is shown in Figure 14.

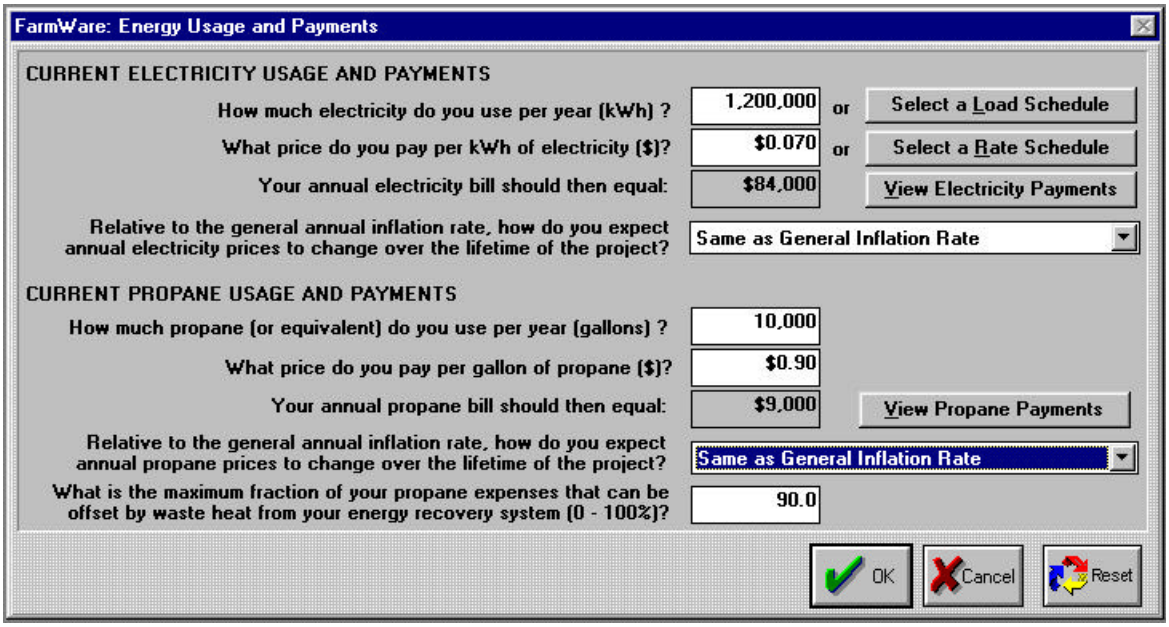


Figure 28: Energy Usage and Payments Screen

Click on OK to save and exit.

Note: More detailed energy usage and rate schedules may be entered using RateVision. Please see the RateVision manual for more details.

6.4 Evaluate Results

To determine whether a biogas recovery system at this farm will be a profitable investment click on the quick analysis icon the tool bar or select ***Quick Financial Report*** from the **Analysis** menu. The screen for this report is shown in Figure 15 below. The top part of this report contains estimates for the total capital costs, annual benefits, and annual operating costs of the selected system. The bottom of the box contains values for the NPV, simple payback, NPV payback, IRR, and a message regarding the potential profitability of the selected system.

Appendix E-3 Case Studies

Swine Farrow-to-Finish Farm

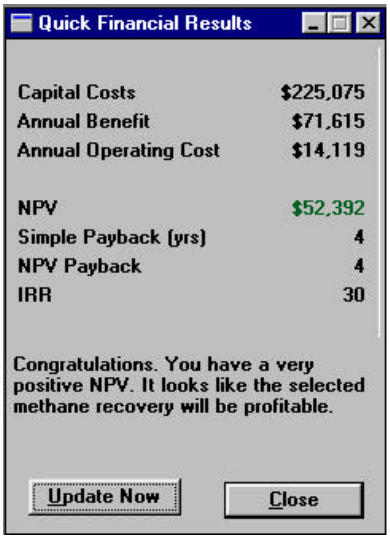


Figure 29: Quick Financial Results screen

The **Quick Report** shows us that the total capital cost of installing a covered lagoon digester at Polka Dot Pig Farm is $225,000. FarmWare estimates that average annual offset benefits are $71,000 and average annual operating costs are $14,000. These costs and benefits yield an NPV of approximately $52,000. In addition, this project is estimated to have a payback of 4 years and an internal rate of return of 30%.

As indicated in the message at the bottom of this report, these measures of economic feasibility show that the installation of a methane recovery system at Polka Dot Pig Farm should be a profitable investment. Mr. Dot should invest in this project for his farm.

AgSTAR

Evaluation Form: Swine Facility

Farm Name: *Polka Dot Pig Farm*
Contact Name: *Mr. Dot*
Phone Number: _____ **Date:** _____

1. SITE CLIMATE INFORMATION

State: *North Carolina* County: *Duplin*

2. FARM TYPE

Type of Farm		Size of Farm		Manure Collection Method		Manure Treatment	
X	Farrow - Finish	*1,400*	sow	*X*	Flush Everything	*X*	Covered Lagoon
	Farrow - Nursery		sow		Scrape Everything		Complete Mix
	Farrow - Grower		sow		Pull Plug Pits or Cascade Dams		
	Finishing only		finishers				
	Nursery		Pigs				

3. LIVESTOCK POPULATIONS

1,400 sows *2,700* nursery *4,300* growers *4,850* finishers *77* boars _____ other

4. MANURE MANAGEMENT

Recycle Flush Systems

Building	Tanks Per Building	Gallons Per Tank	Flush Frequency (# times/day, week, etc.)
1	*10*	*948*	*5 times/day*
2	*6*	*450*	*4 times/day*
3	*4*	*850*	*6 times/day*
4	*8*	*850*	*6 times/day*
5			

Pull Plugs and Recharge

Building	Gallons Per Pit	Plug Pull Frequency (every ? days)
1		
2		
3		
4		
5		

Other Systems

	Gals H2O Per Cleaning	Cleanings Per Day
Scrape		
Open Lot		
Hose Wash		
Other (specify)		

5. ENERGY INFORMATION

(Complete this section, or bypass it by attaching copies of past 12 months of energy bills)

Overall Energy Costs

Annual Electricity Costs: *84,000* $/year Annual Propane Cost: *9,000* $/year
Average Electricity Cost: *0.07* $/kWh Average Propane Cost: *0.90* $/gallon

Monthly Energy Bills (last 12 months)

	Peak	Electric		Propane	
	kW	(kWh)	(Cost)	(gals)	(Cost)
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					

Appendix E-4 Case Studies

Swine Farrow-to-Grower Farm

Farm Profile

Hoggett's Hogs is an 1,500 sow farrow to grower pig farm in Renville county, Minnesota. The manure at Hoggett's Hogs is currently collected in underfloor pits which are pulled once every 5 days. The manure is stored in a single lagoon. The owner of the farm, Mr. Hoggett, has been under pressure by his neighbors to reduce the unpleasant odors associated with his facility, particularly in the Spring. Mr. Hoggett wants to investigate the potential for odor reduction and environmental protection with a methane recovery system. He is also interested in the financial benefits which may result from the offset energy costs.

7. Preliminary Screening for Project Opportunities

A quick review of the farm by the operator, Mr. Hoggett, using the checklists provided in Chapter 2 reveals that:

- There are over 2,000 hogs (on average) at his confined facility.
- The manure is collected: as a slurry, at a single point (single cell lagoon); it is collected daily and is free of clumps of bedding.
- There is a need for on-farm energy. Annual electricity costs amount to over $43,000 and annual propane costs average approximately $18,000. Furthermore, odor is a problem.
- There is adequate technical support.

The above conditions are promising for biogas technology. So, we move on to the next stage of the analysis.

8. Technical and Economic Feasibility Assessment

This assessment consists of four steps:

(1) determining which digester is appropriate for your facility;

(2) gathering facility data for the FarmWare assessment

(3) performing the FarmWare assessment; and

(4) evaluating the results.

Each step is discussed in turn.

8.1 Match Digester to Your Facility

The type of digester to use depends on the climate and total solids content of the manure.

- **Climate.** The farm is located in Renville County in Minnesota. This region is above the line of climate limitation (see Exhibit 4-1 in Chapter 4). The average annual temperature is not warm enough

for biogas production without supplemental heat. A covered lagoon would therefore not be a viable solution. As such, the selected digester for biogas production and recovery should be a complete mix digester with heat recovery.

- **Total Solids Content.** The manure at the facility is collected in underfloor pits. The pits are filled to approximately 12 inches high with recycled water from the storage lagoon. The manure falls into the pits through the slatted floors and is added to this recycled water. Mr. Hoggett pulls the plugs once every 5 days. Mr. Hoggett estimates the water to manure ratio to be 5:1. For such manure, Exhibit 4-4 in Chapter 4, indicates that the total solids content of the manure should be less than 2%. This may be too dilute for optimizing biogas production from a complete mix digester. We will analyze the results with Mr. Hoggett's current management practices and investigate possibilities to increase the total solids later in this case study.

8.2 Complete Evaluation Forms

These forms record the data required for the FarmWare analysis. The completed evaluation form for Mr. Hoggett's facility is attached.

8.3 Enter Information Into FarmWare

Once the evaluation forms are complete, the information is entered into FarmWare. For information on how to use FarmWare, refer to the FarmWare manual, which can be found in Appendix D. Mr. Hoggett completed the FarmWare assessment for his facility as follows.

8.3.1 Site Climate Information

The first step is to enter the location of Hoggett's Hogs into FarmWare. Click on the climate icon on the tool bar or select **Location and Climate** from the **Design** menu.

➡ *From the drop down lists, select Renville County, Minnesota.*

The completed Site Location and Climate Screen is shown in Figure 1:

Appendix E-4 Case Studies

Swine Farrow-to-Grower Farm

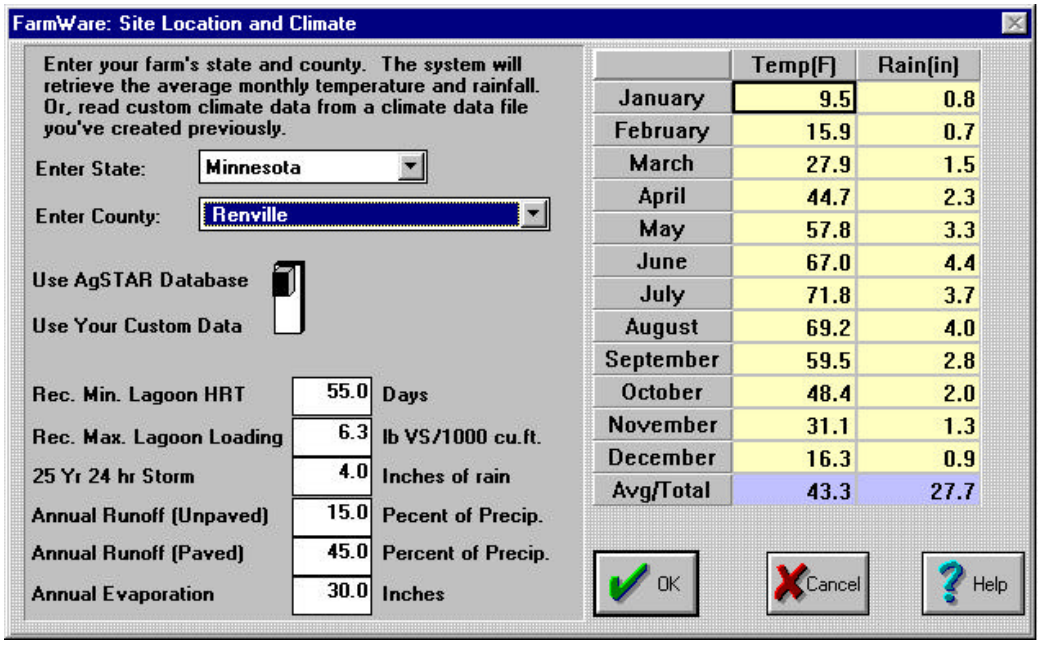


Figure 30: Site Location and Climate Screen

FarmWare has retrieved the average temperature and rainfall data for Duplin County, NC as well as other climate data including the 25-year, 24-hour storm event. The temperature and rainfall data is based on National Climate Data Center (NCDC) data.

8.3.2 Farm Type

The next step is to enter information about the farm type and manure collection and treatment methods. Click on the farm type icon on the tool bar or select **Farm Type** from the **Design** menu.

- *Select **Swine: Farrow to Grower** from the "Select a Type of Farm" drop down list.*
- *Enter **1,500** in the "Select a Farm Size" box.*
- *Select **Pull Plug or Cascade Dam** from the "Select a Manure Collection Method" drop down list.*
- *Select **Storage Pond** from the "Select a Manure Treatment/Storage Facility" drop down list.*
- *Check the **Complete Mix Digester** box in the lower left hand corner of the screen.*

These selections are used to create a manure template for Hoggett's Hogs. The completed Farm Type screen for Hoggett's Hogs is shown in Figure 2:

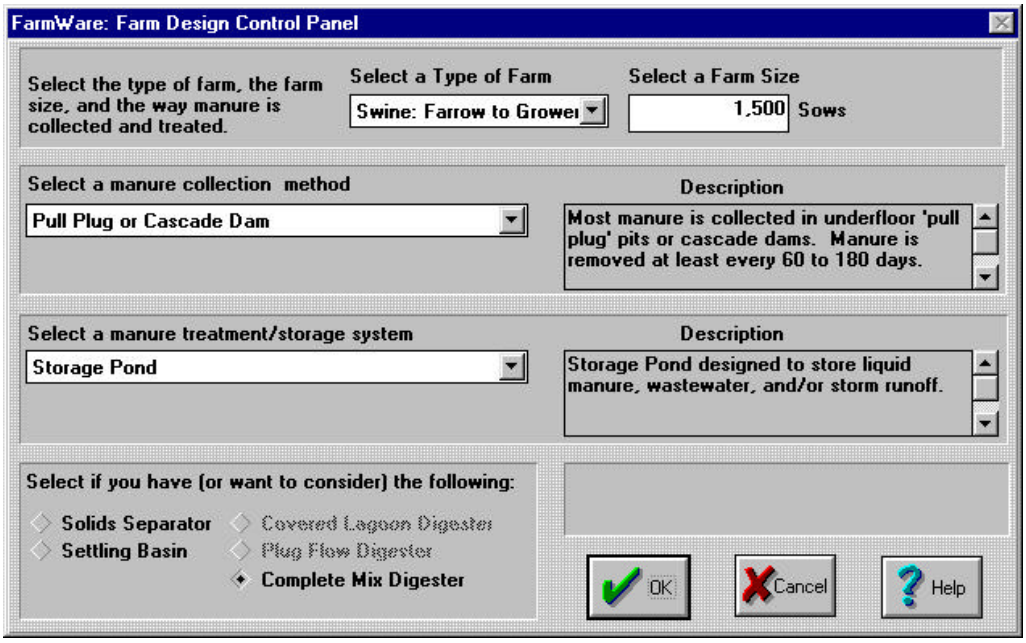


Figure 31: Farm Type Screen

Click on OK to save and exit this screen.

8.3.3 Livestock Populations

The next step is to enter the number of animals at Hoggett's Hogs. Click on the livestock number icon on the tool bar or select **Livestock Number** from the **Design** menu.

The Livestock Control Panel contains a table of default animal numbers and weights which are based on the type and size of farm entered in the Farm Type screen (in this case 1,500 sow farrow-to-grower). You may edit these numbers by clicking in the appropriate cream colored boxes and entering the correct values.

For Hoggett's Hogs, enter the following animal numbers:

- *Sows:* *1,500*
- *Nursery:* *3,450*
- *Grower:* *4,600*

The completed Livestock Number screen is shown in Figure 3.

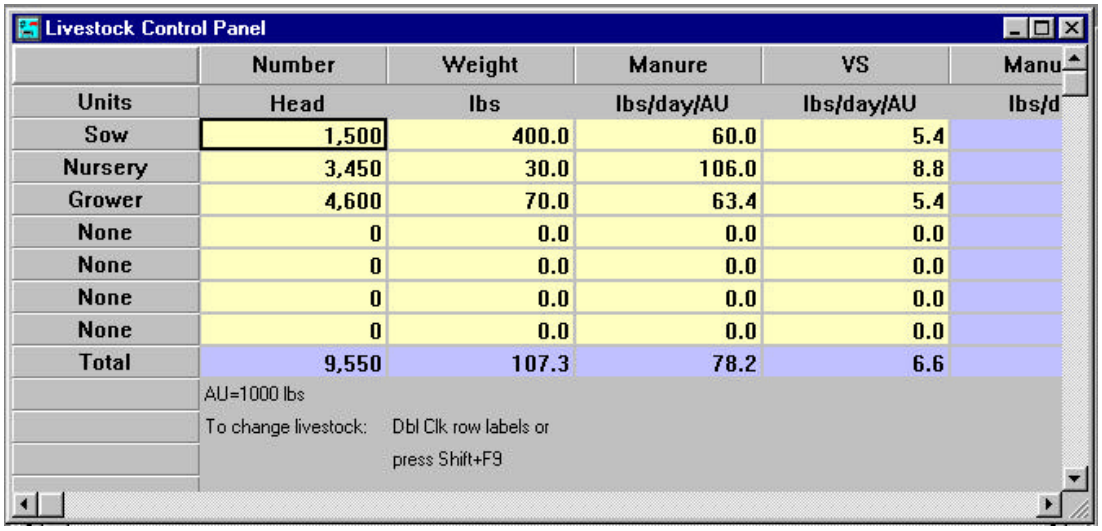


Figure 32: Livestock Number Screen

Double click on the upper left hand corner of this screen to exit.

8.3.4 Manure Management

The next step is to define the individual components of the manure management system. Click on the train icon on the tool bar or select **Management Train** from the **Design** menu.

The **Management Train** screen (Figure 5) shows the collection and treatment methods for the facilities at the farm. In this example, this screen shows that the manure from each of the confinement facilities is collected in pull plug pits. The manure is flushed into a mix tank and then into a complete mix digester. After digestion the manure is stored in a storage pond.

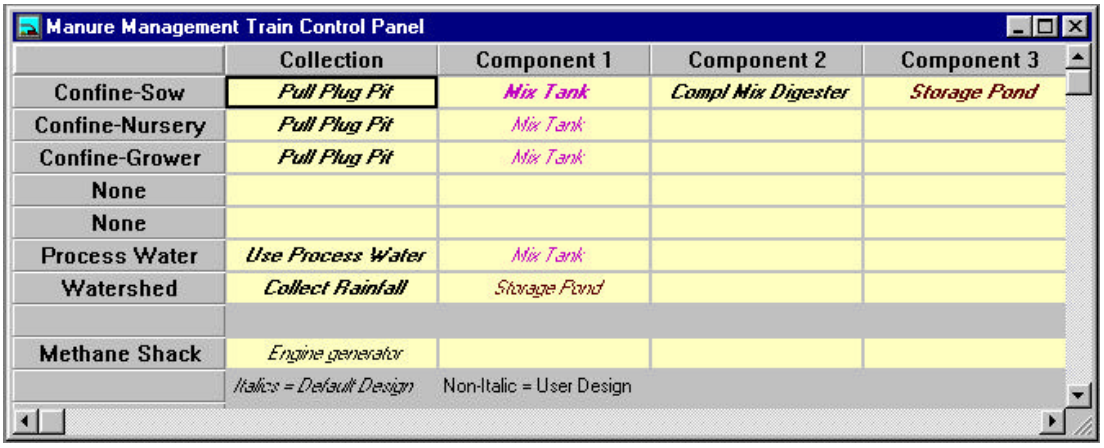


Figure 33: Manure Management Train Screen

To ensure that the complete mix digester is sized correctly you must accurately describe the water use in the pull plug pits. Each of the "Pull Plug Pit" components in this screen must therefore be defined.

Pull Plug Pits

Place the cell cursor over the Pull Plug Pit component immediately to the right of the Confine-Sow Facility in this screen. Double click on this cell or click on the Design component icon in the floating tool box.

➡ *Enter **5** in the "Storage Period" box.*

➡ *Enter **85,000** in the "Recharge Water" box.*

The finished screen is shown in Figure 34.

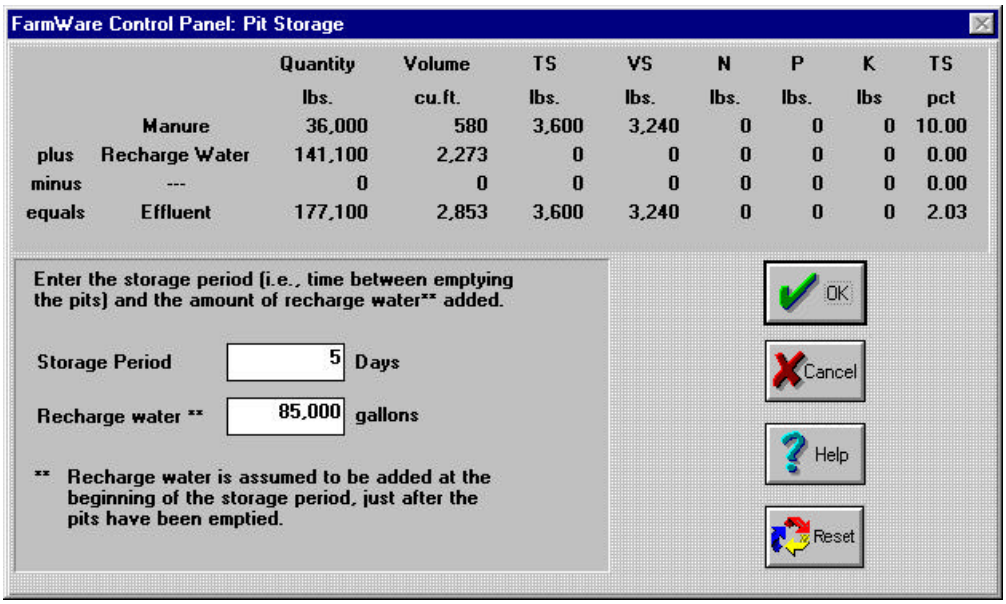


Figure 34: Pull Plug Pit Screen for the Confinement-Sow Facility

This information is very important in designing a methane recovery facility as it directly affects the size of the complete mix digester. The more recharge water that is being added, the greater the volume of the complete mix digester needed to store and treat the manure influent.

➡ *Follow the above steps to design the pull plug pit components for the nursery and grower confinements using the information below:*

Table 2: Confinement Data for Hoggett's Hog Farm

Confinement	Storage Period	Recharge Water
Nursery	5	25,000
Grower	5	48,000

Process Water

Consideration should be given to the amount of process water entering the manure management system. FarmWare accounts for this process water in it's own design box labeled in the Manure Management Screen as Process Water. Hoggett's Hogs accounts for the process water in the pull plug pit design

screens. The excess process water included by default therefore should be zeroed out such that it is not included twice in the design of the system. To edit the amount of process water, double click on the Process Water cell or click on the Design component icon in the floating tool box.

➡ *Enter **0** in the "Process Water" box and click on OK to save and continue.*

The importance of process water as well as sources of process water to be considered is detailed in Chapter 3, Section 3-1.2.

Complete Mix Digester

The soil conditions at Mr. Hoggett's farm will allow for a deeper digester than the 10 foot depth used as the default. The Complete Mix Digester Control Panel must therefore be edited to reflect this change. Place the cell cursor over the Complete Mix Digester component in the Confine-Sow Facility row in Manure Management Train screen. Double click on this cell or click on the Design component icon in the floating tool box.

➡ *Enter **0.5** in the "Freeboard" box.*

➡ *Enter **12** in the "Depth" box.*

The finished screen is shown in Figure 35.

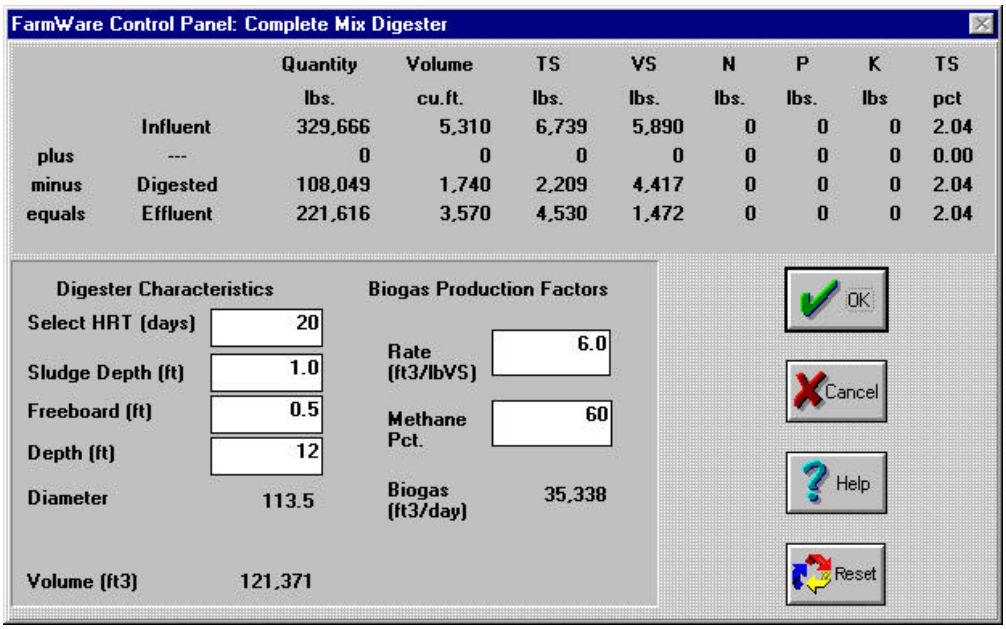


Figure 35: Complete Mix Digester Screen

Note the total solids content of the manure entering the digester. This value is listed in the far right column under "TS pct". The total solids at Hoggett's Hogs is 2.04%, a value typically low for complete mix type systems. We will continue with our analysis using these values and Mr. Hoggett's current manure management practices and will later explore potential methods of increasing the total solids.

Engine Generator

The cool climatic conditions in Renville County, Minnesota require that the digester be heated with supplemental heat generated from the biogas produced within the digester. A heat exchanger will provide enough heat to keep the manure at the optimal biogas production temperature. To ensure that the costs associated with a heat exchanger are included in the financial analysis of Hoggett's Hogs we must edit the Engine Generator Control Panel. Place the cell cursor over the Engine Generator component in the Methane Shack row in Manure Management Train screen. Double click on this cell or click on the Design component icon in the floating tool box.

➡ *Select "**Yes**" from the "Include Heat Recovery?" drop down list.*

The completed Engine Generator Control Panel should look like Figure 36 below:

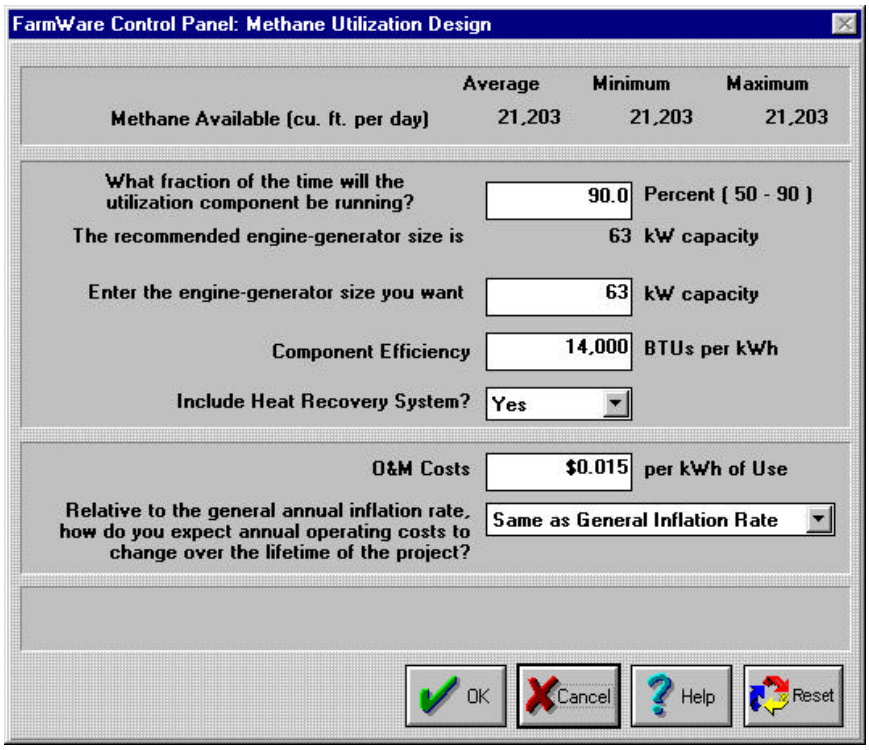


Figure 36: Engine Generator Screen

Note the methane available at the top of the screen and the recommended engine-generator size in the center of the screen. Hoggett's Hogs can produce approximately 21,000 cubic feet of biogas per day, enough gas to generate up to 63 kW of capacity.

When you are finished designing the all of the manure management train components, double click in the upper left hand corner of the Management Train screen to save and exit.

8.3.5 Energy Information

The next step in this case study is to enter the energy use and rates at Hoggett's Hogs. Click on the energy icon on the tool bar or select **Energy Prices** from the **Design** menu.

In this screen, you may enter the current price per kWh of electricity, the price per gallon of propane, the approximate amount spent per year on electricity and propane, and the annual growth rate for expenses based on the location and size of the farm. Default values for each of the above categories are provided and should be edited to most accurately reflect the current energy costs to Hoggett's Hogs.

- *Enter **584,000** for the amount of electricity purchased per year.*
- *Enter **$0.075** for the price per kWh of electricity.*
- *Enter **25,000** for the amount of propane purchased per year.*
- *Enter **$0.75** for the price per gallon of propane.*

The total amount of cost of electricity per year should equal $43,800 and the total cost of propane per year should be $18,750. The completed Energy Prices screen for Hoggett's Hogs is shown in Figure 14.

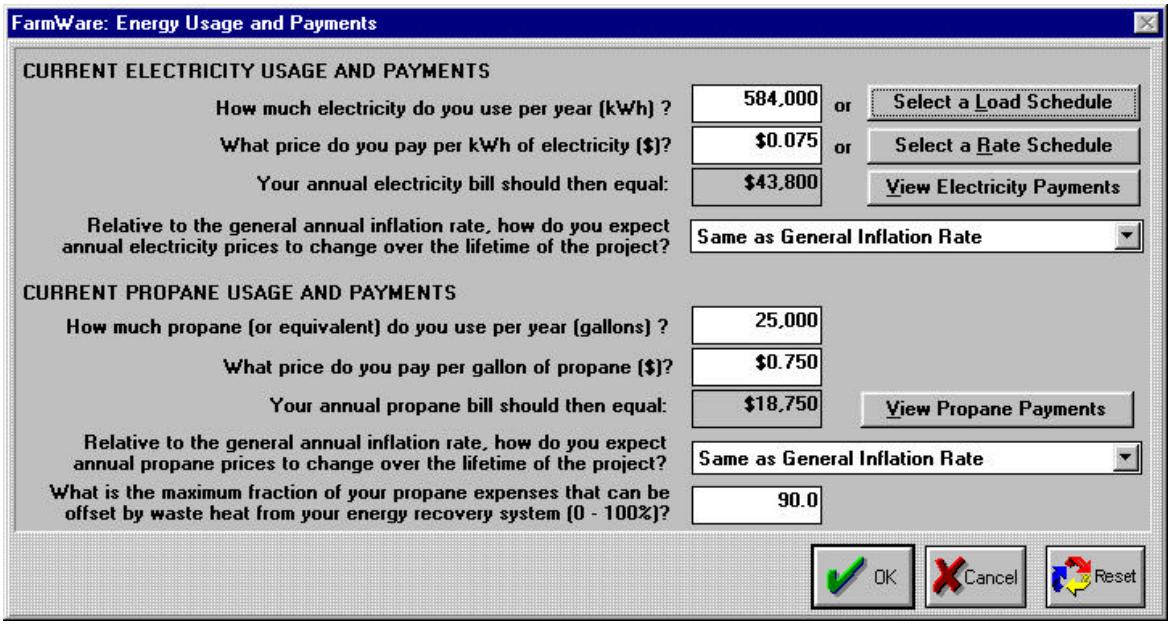


Figure 37: Energy Usage and Payments Screen

Click on OK to save and exit.

Note: More detailed energy usage and rate schedules may be entered using RateVision. Please see the RateVision manual for more details.

8.4 Evaluate Results

To determine whether a biogas recovery system at this farm will be a profitable investment. Click on the quick analysis icon the tool bar or select ***Quick Financial Report*** from the **Analysis** menu. The screen for this report is shown in Figure 15 below. The top part of this report contains estimates for the total capital costs, annual benefits, and annual operating costs of the selected system. The bottom of the box contains values for the NPV, simple payback, NPV payback, IRR, and a message regarding the potential profitability of the selected system.

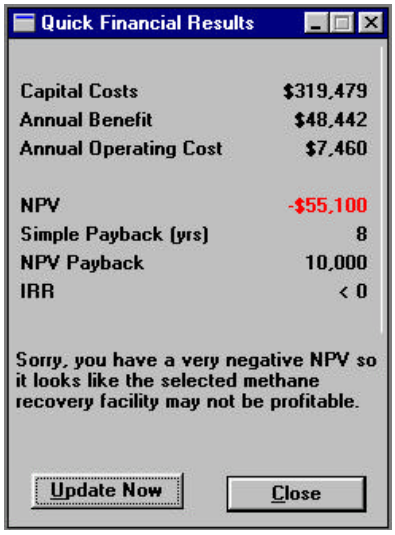


Figure 38: Quick Financial Results screen

The **Quick Report** shows us that the total capital cost of installing a complete mix digester at Hoggett's Hogs is $319,000. FarmWare estimates that average annual offset benefits are $48,000 and average annual operating costs are $7,500. These costs and benefits yield an NPV of approximately -$55,000. In addition, this project is estimated to have a payback of 8 years and an internal rate of return of <0%.

As indicated in the message at the bottom of this report, these measures of economic feasibility show that the installation of a methane recovery system at Hoggett's Hogs may not be a profitable investment. Mr. Hoggett should investigate whether changes in his manure management practices may yield more positive results.

8.5 Change Manure Management Practices

Hoggett's Hogs, like many other farms across the country, uses excess water in the manure management system. The amount of water used at Hoggett's Hogs is very important for sizing the complete mix digester as well as for optimizing biogas production from the system. Excess water and increased waste volume can limit the capacity of manure handling and storage facilities. If Mr. Hoggett can decrease his water usage at Hoggett's Hogs, the complete mix digester will be smaller in size and the total solids content of the manure entering the system will be greater. A smaller digester will have less area to cover which will decrease the capital cost of installing the system. In addition, the increased solids will bring the influent manure consistency closer to the target percentage for complete mix digesters of 3-8%. The combination of these two factors may make the project more economically feasible for Mr. Hoggett.

Currently Mr. Hoggett pulls his plug pits once every 5 days. The pits are filled with 12 inches of recycled water. The total water usage in each of the facilities is as follows:

Table 3: Current Water Management at Hoggett's Hogs

Confinement	Storage Period	Recharge Water
Sow	5	85,000
Nursery	5	25,000
Grower	5	48,000

If Mr. Hoggett can increase the pit storage period and decrease the amount of water used to fill the pits the methane recovery system may be profitable at Hoggett's Hogs. We will investigate the possibility of increasing the storage period to 10 days and decreasing the amount of water used to fill the pits by one half. A summary of the new water usage is detailed below:

Table 4: Suggested Water Management at Hoggett's Hogs

Confinement	Storage Period	Recharge Water
Sow	10	42,500
Nursery	10	12,500
Grower	10	24,000

To see what effect this reduced water may have on the system, re-enter each of the three "Pull Plug Pit" screens in the Manure Management Train and enter the above information.

8.6 Reevaluate

After making the above changes to the water usage at Hoggett Hogs we may reevaluate the results. Click on the quick analysis icon the tool bar or select ***Quick Financial Results*** from the **Analysis** menu. The screen for this report is shown in Figure 39 below.

Appendix E-4 Case Studies

Swine Farrow-to-Grower Farm

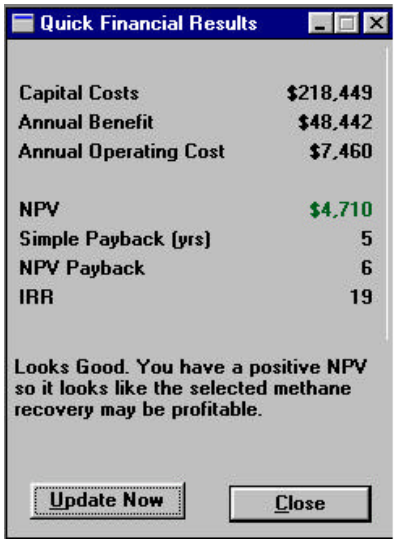


Figure 39: Quick Financial Results Screen

The changes in water management are apparent when viewing this Quick Report. This report shows us that the total capital cost of installing a covered lagoon digester at Hoggett's Hogs is now about $218,000 (as compared with $319,000). The average annual offset benefits are still $48,000 and average annual operating costs are $7,500. These costs and benefits however now yield an positive NPV of approximately $4,700. In addition, this project is estimated to have a payback of 5 years and an internal rate of return of 19%.

As indicated in the message at the bottom of this report, if Mr. Hoggett can change the manure and water management practices as described he may profitably recover methane from his manure management system.

AgSTAR

Evaluation Form: Swine Facility

Farm Name: *Hoggett's Hogs*
Contact Name: *Mr. Art Hogget*
Phone Number: _____ **Date:** _____

1. SITE CLIMATE INFORMATION

State: *Minnesota* County: *Renville*

2. FARM TYPE

Type of Farm	Size of Farm	Manure Collection Method	Manure Treatment
_____ Farrow - Finish	_____ sow	_____ Flush Everything	_____ Covered Lagoon
_____ Farrow - Nursery	_____ sow	_____ Scrape Everything	*X* Complete Mix
X Farrow - Grower	*1,500* sow	*X* Pull Plug Pits or Cascade Dams	
_____ Finishing only	_____ finishers		
_____ Nursery	_____ Pigs		

3. LIVESTOCK POPULATIONS

1,500 sows *3,450* nursery *4,600* growers _____ finishers _____ boars _____ other

4. MANURE MANAGEMENT

Recycle Flush Systems

Building	Tanks Per Building	Gallons Per Tank	Flush Frequency (# times/day, week, etc.)
1			
2			
3			
4			
5			

Pull Plugs and Recharge

Building	Gallons Per Pit	Plug Pull Frequency (every ? days)
1	*85,000*	*5 days*
2	*25,000*	*5 days*
3	*48,000*	*5 days*
4		
5		

Other Systems

	Gals H2O Per Cleaning	Cleanings Per Day
_____ Scrape	_____	_____
_____ Open Lot	_____	_____
_____ Hose Wash	_____	_____
_____ Other (specify)	_____	_____

5. ENERGY INFORMATION

(Complete this section, or bypass it by attaching copies of past 12 months of energy bills)

Overall Energy Costs

Annual Electricity Costs: *43,800* $/year Annual Propane Cost: *18,750* $/year
Average Electricity Cost: *0.075* $/kWh Average Propane Cost: *0.75* $/gallon

Monthly Energy Bills (last 12 months)

	Peak	Electric		Propane	
	kW	(kWh)	(Cost)	(gals)	(Cost)
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					